METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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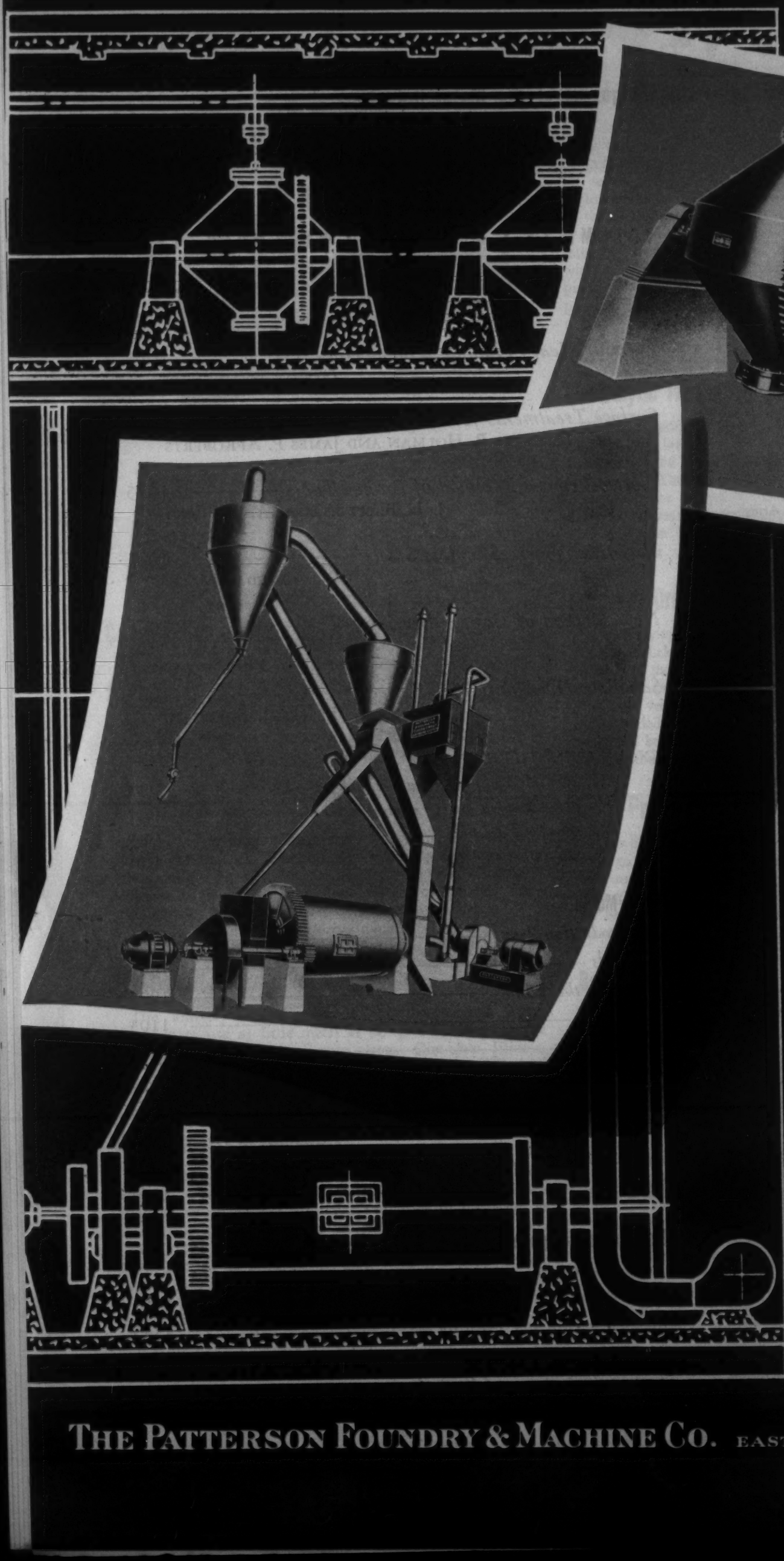

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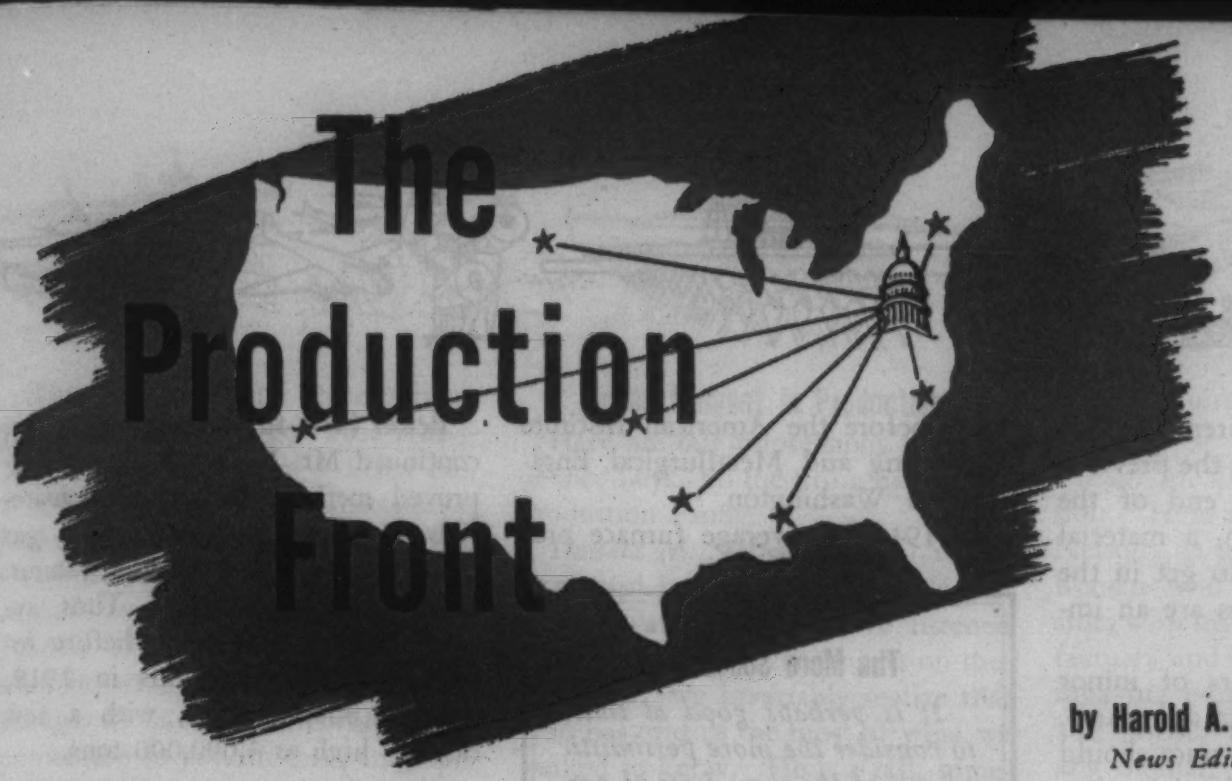


by Harold A. Knight
News Editor

Bottlenecks first critical metals, then components and now a new group. . . . Metals and components have been licked. . . . New scarcities are lumber, and wood products, small motors, signal equipment and heavy trucks. . . . We've practically reached peak production. . . . Aircraft and tank production go in opposite directions.

Scrap aluminum actually gets in the way. . . . High grade zinc retorts shut down. . . . WPB more liberal with steel each day. . . . We've produced 22 billion rounds of small arms ammunition. . . . Average blast furnace produced 349 tons in 1918; today 700 tons. . . . We could increase output 25 per cent by better use of available labor.

For every two women hired, one quits. . . . Our "poetoonist" (poet-cartoonist) jingles about bottlenecks. . . . "Five-cent aluminum before the war ends." . . . How the Washington headline boys look to us. . . . The typical Army-Navy "E" ceremony. . . . Extreme cold tests of aircraft lubrication, fluids and packing materials. . . . Behold our industrial system!

Styles in Bottlenecks Ever Change

Trying to keep a not-too-well-manicured finger on the pulse of things through periodic trips to Washington, we have felt a series of bottlenecks pulsate through the veins of war production. This is, of course, a mixed metaphor, but is, perhaps, appropriate because of the mixed situation constantly prevalent at our Capital.

A year ago the great pinch point was the supply of base metals some called critical, some strategic. Six months later they were starting to forget basic materials and were concentrated on "components," such as valves, compressors, heat exchangers, fans and pumps.

But recently we were again at Washington with our pulse finger in fine fettle. A high official of WPB allowed us to examine the various bottleneck exhibits, some being museum pieces by now. "On materials, we're out of the woods," he confided. "The components are working out satisfactorily," he continued.

But a new flock of tight items have raised their ugly heads. Fractional horse-power motors hold up many enterprises. There is a great scramble to produce electrical signaling equipment, such as Radar, walkie-talkies, etc. There is a tremendous and unfilled demand for very heavy trucks.

The worst bottleneck of all is now outside the metals field—lumber and wood products. Too much had been used to save steel. We need 60,000 more lumber workers in the forests, in lumber and wood pulp mills—not only for print paper but for paper containers, crates, etc. for our armed forces. Textile and leather supplies are bad. There is a strain involving malleable castings, forgings, diesel engines and landing craft.

Production Mighty Close to Ceiling

The guides at Washington still say that their cries of metal scarcity several months ago were not mere cries of "Wolf, Wolf!" Actually, there would be acute cries today of the same but for the fact that our fabricating program has bogged down below idealistic goals because of manpower shortage. It begins to look as if we had about reached over-all ceiling production.

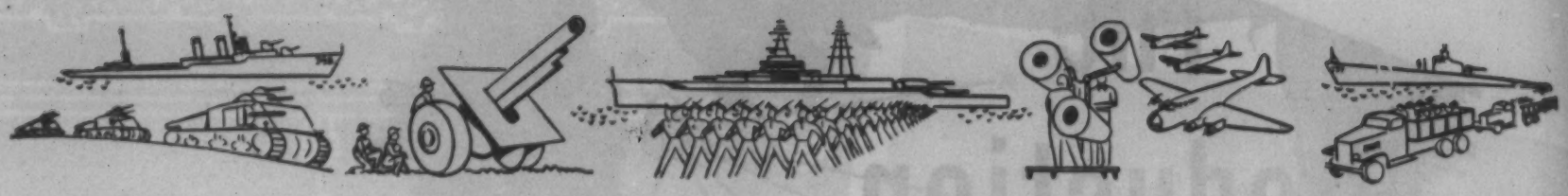
Just when we seem to forge ahead here a crevasse appears there, and the same promises to continue indefinitely. As one Washingtonian expressed it: "Now we are running up against ceilings whichever way we turn. There is not the resilience of a year ago."

The new slogan at the Capital is: "As aircraft goes, so goes production." Aircraft as a war weapon has proved itself beyond all expectations except those of a very few, including the one who wrote the book, "Victory Through Airpower."

Almost to the degree that aircraft is in the ascendancy, military tanks are degenerating. The tank is ever proving a very vulnerable and clumsy weapon. It is reported that Russia has soured on American tanks, partly because the driver occupies an inaccessible quarter. When he is put out of action, the entire tank is dead, whereas in the Russian tank, four men are in position to drive it.

Metal Scarcity Like Shifting Sands

For the past three or four months carbon steel has been the No. 1 critical metal, but the situation improves rapidly. During the first quarter of 1944 the supply will come within 10 per cent of meeting all war and es-



sential civilian requirements as against 20 to 25 per cent the previous quarter. At the other end of the scale is scrap aluminum, a material that is so abundant as to get in the way. Wrecked airplanes are an important source.

Occasionally one hears of minor metals and minerals that are scarce. Lithium and its salts and mica should be much freer in supply than they are. The antimony supply could be much more comfortable. Nickel is barely sufficient for war needs. By contrast, high grade zinc is so abundant that some retorts have been shut down.

That steel and metals are more plentiful becomes evident each day from the revised rules and directives from WPB. Just on one typical day it is decreed, for instance, that "stainless steel may now be used in buckets and pails for use in chemical plants and plants handling explosives"; that "all kinds of iron and steel are permitted in the manufacture of weed cutters and clean-out doors"; "longer fenceposts made from steel rails for snow fences may now be used"; "concrete reinforcing bars should be used where possible to save lumber."

Measure It All in Guns and Bullets

Now then, what are some of the results of all this effort to produce? The *Army News* stated recently: "Since the outbreak of the war Army Ordnance has turned out one piece of artillery for every 46 American soldiers, more than 1,000,000 machine guns and 5,000,000 rifles and submachine guns.

"Production of small arms ammunition has reached the astronomical figure of 22,000,000,000 rounds—enough to fire 1,500 bullets at every soldier in the Axis armies."

Figures comparing production now with that of the first World War are always enlightening. There are no more basic figures than those of pig iron output. During 1942 one-third more iron was produced by the 230 blast furnaces in the U. S. than by the 351 in 1918, stated C. D. King, chairman of the Operating Committee, United States Steel Corp. of Delaware, before the American Institute of Mining and Metallurgical Engineers in Washington.

In 1918 the average furnace produced 349 net tons daily against over 700 today; then the largest furnace turned out 630 net tons daily as against several which now produce 1,500 tons daily.

The More Sober Side

It is perhaps good at times to consider the more pessimistic phases of the war. Loss of personnel among the R.A.F. night flyers is 8 per cent; for the American day bombers, "considerably higher." Losses of the last wave of each bombing mission run 50 per cent. There are other losses from airmen who become permanently injured, either physically or mentally. The bottom of the barrel is in sight for English airmen—they are using more Canadians constantly.

When communiques mention "30 bombers lost," another 30 may have barely returned, "coming home on a wing and a prayer," perhaps with only one crewman alive. Airplane repair shops are glutted. German anti-aircraft defense is ever stiffer. They have a flying "bazooka," which is deadly, directed magnetically or exploded by sonic devices.

New German underwater torpedoes, which played hob with a Canada-bound convoy, may be electric-powered, steered magnetically or sonically and contain new powerful explosive. They tend to hit propellers, the point of maximum vibration.

A German long range rocket, with super duper explosives, may soon shoot from France into the heart of London, directed by radio.

Better blast furnace records today, continued Mr. King, are due to improved methods of charging materials, air blowing, blast heating, gas cleaning and slag handling systems. Linings are better today. Thus, average furnace production before relining was 625,000 tons in 1918; today, 1,800,000 tons, with a few cases as high as 3,000,000 tons.

A Thought or Two on Labor

So far we have dealt with materials and machines, but, of course, labor is the all-important element in production. If full utilization of manpower could be secured, production would be increased 25 per cent, states Jack Skelly, assistant director, WMC's bureau of utilization.

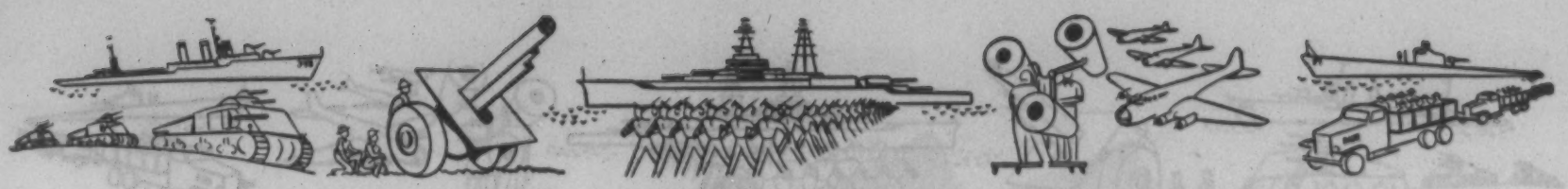
He says further: Efficiency of manpower utilization ranges from 100 per cent to as low as 30 per cent; relative inefficiency of war plants is not a result of deliberate labor hoarding, but lack of knowledge of the employer to use best what he has; too many employers regard production as their sole job—let the Government supply workers and community facilities.

As of Oct. 1, the number of labor market areas where there are acute labor shortages had risen to 71 from 59 when the last survey was taken.

For every two women hired for war production work in labor shortage areas during June, one woman quit her job. Among the reasons for this higher turnover are: marriages; births; the fact that some women work during a family financial crisis only; soldiers' wives follow their husbands from district to district; inadequacy of child care by outsiders; and the added burden of housekeeping.

What! Five-Cent Aluminum?

On a dull uneventful day, the following statement became focused in our eyes: "Cost reduction will spur a vast post-war development in aluminum. Before this war is over pig aluminum will probably be down to 5 cents a pound, as compared with a pre-war price of about 23 cents. Countless manufacturers will make greater use of it."



This comprised the seventh paragraph in "Planning for Post-War—A Griswold Newsletter"—Letter No. 1 (off to a good (?) start, certainly), Sept. 30, 1943. The author is Glenn Griswold, former publisher of *Business Week* and editor of the *Chicago Journal of Commerce*. "Reproduction in whole or part forbidden," though we have Mr. Griswold's kind permission to publish this paragraph.

The price of aluminum is now 14 cents per pound; copper is 12 cents. Our first thought was a recollection of when copper sold at 5 cents during the worst of the depression in 1932. That price just about put copper producers out of business. What would happen to copper if aluminum sold at 5 cents?

We consulted a few experts and, to our astonishment, found some agreement with this 5-cent prediction. Another authority, however, professed himself to be "astounded" at this statement in so far as virgin metal is concerned, though conceded that this might prove a common price for certain grades of secondary metal, particularly where the buyer is not fussy as to its composition.

One suggested that with pig aluminum at 14 cents, copper even now should theoretically be under 5 cents to compete on a volume basis. Another suggested that the metal industry must become reconciled to a new deal in metal prices. Copper henceforth will be one of the precious metals along with tin.

Another was inspired to suggest that in post-war the cheapest metals, per cu. ft. and in order named, will be iron, aluminum and magnesium.

Price reductions in aluminum during the past 3 years have been: March 25, 1940, from 20 to 19 cents; Aug. 1, 1940, to 18 cents; Nov. 18, 1940, to 17 cents; Aug. 21, 1941, to 15 cents. Pig aluminum, the product of the electrolytic cell, was offered at 14 cents Dec. 5, 1942.

Do price reductions already made have any bearing on future prices? Will reductions continue at the same rate as to price levels and time intervals?

Human Element in Production

Here are our impressions of some of the "boys" on the firing line of the Production Front:

Donald M. Nelson, WPB. When we return home from a Washington meeting, at which we have listened to talks by some dozen fingers-on-the-pulse-men, we invariably realize that Don has told us the most of what we wanted to know. He is a tall, somewhat portly man, with highly arched eyebrows (if a woman, we'd say he'd been to the beauty parlor for an eyebrow tonsorial treatment). In his hand, for emphasizing his points with gestures, is a curved stem pipe. His mien is ever serious.

Every situation is a crisis, but not without hope. He speaks in a low voice, easily and fluently. He never wastes a word. He does not speak in generalities. He is on our level—not above, not below. Somehow, he would be a good fellow to go fishing with; he'd do his share of rowing the boat, wouldn't talk too much, yet would entertain us with interesting, sensible conversation when the fish didn't bite.

Paul McNutt, Manpower Commission. Here is a contrast to Donald Nelson. A great handshaker; a noble Roman who sways the Roman senators with his physical force, powerful features and oratorical fireworks; his toga fits perfectly; his hair is fluffy and white, not slicked down with any Sicilian olive oil.

Yet, somehow, his logic and persuasiveness are not the equal of Don Nelson's—there are flaws in his oratorical armor.

Major-General Levin H. Campbell, Army Ordnance. Here is a dynamo of a Scotsman, who not only takes his hair down with you, but fairly strips to the waist. He is like the character in the spark plug ad—"so tough and yet so gentle."

He is anxious for your good will, and wants you to believe thoroughly in the superiority of U. S. ordnance. He is an interesting speaker, frank, colorful and far more than an armchair strategist.

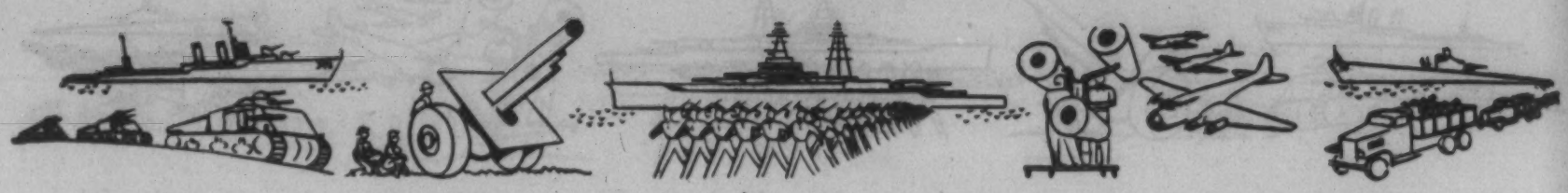
No Bottlenecks Above the Neck!

by V. M. McConnell

We've had a lot of bottlenecks to crack
And some of them wuz tough and some wuz not.
And all of them revealed a certain lack
Which might o' stopped production on the spot.

Chorus

The Bottlenecks come sneaking up
And says, "We got yu now.
We'll stop that flow of battleships and planes."
Says we, "Go back to Germany
We got you licked and how
For there ain't no Yankee bottlenecks in brains."



Major-General Lewis B. Hershey, Jr., Selective Service. He is not at ease as a speaker, but he does his damnedest to conceal it. He grabs the microphone with a 100-lb.-per-sq.-in.-grip, and pours forth a torrent of language, fearing that if he once hesitates he is lost. The hand that does not grip the microphone mops his forehead.

He produces a laugh from the audience on every page, a guffaw once a minute, and a smile in every paragraph, his wit bordering on the screwball type. But, with it all, he sends out a solid message.

Prentiss Brown, O.P.A. Mr. Brown could be a successful merchant, banker or manufacturer. He is just the average successful American, with a little over-average intelligence and ability. He is the diplomat type, who does not try too hard to force his own opinion but believes that true leadership skill lies in harmonizing and harnessing opposing views of his co-advisors.

C. E. Wilson, W.P.B. Here is a "natural" for a production executive. He's a little on the serious side, and is not one to wisecrack or court wit or nonsense. A big, well-proportioned, ruddy-faced man, we imagine he feels more at home in the shop and adjoining office than on the speaker's platform.

Our toastmaster intrigued him into making a speech. He had agreed to appear if he was not required to make speeches—just answer questions. So the toast master asked: "What is the general situation as to war production?" A speech had to follow.

Let's Record It in a Time Capsule

We attended an Army-Navy "E" award celebration of Callite Tungsten Corp., Union City, N. J., in the stadium of that city. Approximately at the pitcher's box were two roofed platforms, the larger for the speakers and special guests, the smaller for the Hudson County American Legion band, in French blue uniforms and shiny white metal helmets (presumably of non-critical materials).

The stadium was lavishly bedecked in American flags and red, white and blue bunting. Pretty usherettes with dark blue tam o'shanter hats, trimmed with red, white and blue ribbons, pinned carnations on special people, such as parents of former employees in service.

Four husky negro infantrymen maneuvered around the speakers' stand. The urbane radio announcer, Alois Havrilla, presided. Prior to the formal program, the band played old favorites, such as "My Wild Irish Rose," the leader inviting the public to sing.

Highlights of the program: "America," sung by Jean Merrill of Station WOR; presentation of the "E" by Maj. Clenen J. Bishop; acceptance by Charles H. Kraft, president of Callite Tungsten.

After the raising of the "E" flag, it was announced that all employees might then take out their individual "E" pins from the sealed envelopes —and amid a great rustle of envelopes being torn, this was done and pinned to lapels. By far the greatest applause greeted Edwin C. McGowan, chief steward, United Electrical, Radio and Machine Workers of America, Local 448, who formally accepted the individual "E" pins.

President Kraft made a most appropriate speech. All highest honors to the men on the fighting front—the production front is secondary after all, but terribly important.

And so do patriotic gatherings assemble throughout our land. A sound film of this and similar proceedings should be buried in a Time Capsule for the supermen of 5000 years hence to inspect. Surely this all is an important sector of Americana, A.D. 1943!

Research on Extreme Cold

We have noted considerable interest recently on the part of our readers in the broad subject of refrigeration in connection with metals. Just the other day, for instance, a lieutenant from the Naval Proving Ground at Dahlgren, Va. asked us information on subzero machines that function as low as minus 150 deg. F.

We have already published two feature articles on the subject, and will publish more. Recently we sent out a series of letters to steel companies and progressive research departments of leading aircraft companies to find out what data they possess on the behavior of metals under extremely cold temperatures—high flying being what it is.

The following reply is typical, this coming from the chief research engineer of Republic Aviation Corp., Farmingdale, L. I. He says:

"We have a cold room which has been in operation for approximately six months and in which we have reached temperatures as low as minus 100 deg. F. The type of tests which we have conducted have been operational tests on various aircraft accessories, such as hydraulic systems, landing gear oleos and trim tab systems.

"The main source of trouble has been in the lubrication, fluids and packing materials. These difficulties are far greater than any which we may expect from the behavior of metals at low temperatures, so that practically no investigation has been made on the metals themselves."

And, while we're on the subject, we were in a group of some 40 metal men the other day when one asked the question: "What can be done to keep mercury from freezing at 40 deg. below zero? (Mercury, of course, is used in thermometers and various indicators and controls in aircraft.) A consulting engineer answered: "By adding thallium."

Behold Our Industrial System!

"The production record of American business during the past two or three years should be a complete answer to those critics, or advocates of a new economic order, who not so long ago advanced the notion that our industrial system is moribund and incapable of meeting the needs of the nation. As events have amply demonstrated, private industry is a very live and potent force, which today is making a mighty contribution to the country's war effort."—(Irving S. Olds, chairman, U. S. Steel Corp.)

Adventure on the Production Front

All glory to the young fighting men on the front! Theirs is the ultimate in sacrifice—and in adventure. Yet the older generation back home in the war plants have had adventures galore that will all come out in the history books.

Perhaps no more stirring saga of production exists than the development of the Winchester carbine which gained popularity over night! Whereas the Garand is for the expert rifleman and sniper, the carbine is a deadly weapon for plain Joe Soldier. It weighs 4 lbs. less than the Garand or Springfield; its cartridges weigh only half as much as standard ammunition. It permits the arming of military personnel, such as engineers, who previously had no room for a rifle. It is semi-automatic. Gas from the exploding cartridge ejects the spent shell and loads the next cartridge.

The real climax surrounding its development came in September 1942. A preliminary model had interested Army Ordnance. The final model was to be at Aberdeen Proving Grounds for competition with guns from six other manufacturers on Sept. 16. It was not until Sept. 12 that all of the 63 parts were finished. But when assembled, the gun would not work satisfactorily, "though it showed signs of wanting to work," as one Winchester man related it.

Throughout most of the night 20 men fumed, fussed and cussed over the gun. Twenty-four hours before the test the gun was still not functioning: The gas to operate the "short stroke" piston mechanism is taken from the barrel through a tiny porthole 3 in. from the mouth of the chamber, the original having been 0.06 in. in diameter.

That mere "pore" of a hole, it was decided, should be enlarged. As this was being done, the drill broke off inside the hole. It was several hours later that the stubborn bit was removed, the hole completed with a new drill and the gun sent to the testing range. Without a stutter the carbine fired 300 shots as fast as cartridges could be fed into the breech. Next day the Winchester carbine was the unanimous choice of the Army board of judges.

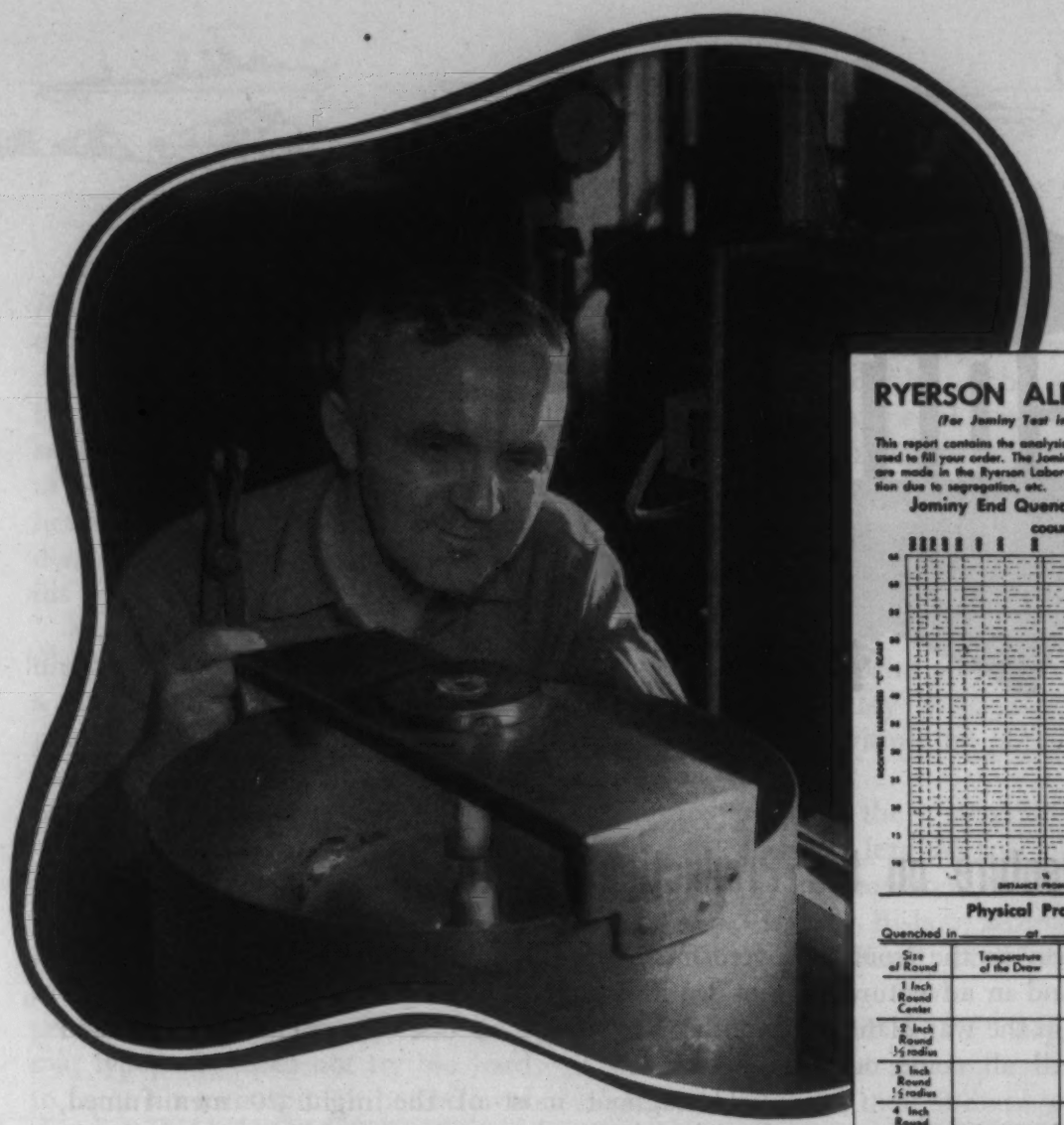
Success depended on 0.013 in., the amount the hole had been enlarged! Surely there is drama on the Production Front! —H. A. K.

Gray Iron Castings

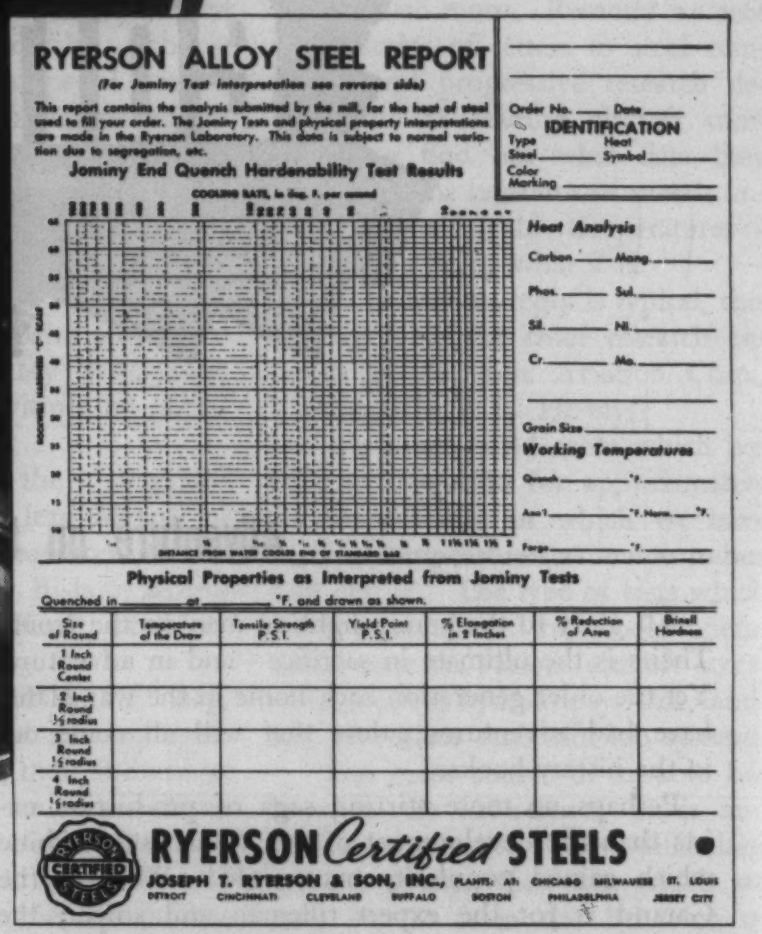
Just back from the annual meeting of the Gray Iron Founders' Society, we are moved to speak straight from the heart (or a point somewhat above it) about the present position and future prospects for the manufacturers of gray iron castings.

It is no secret that the gray iron industry is today the victim of a vicious production-squeeze. Unable under the O.P.A. to raise the prices they charge for their products, the job foundries are nevertheless faced with rising costs of their operating materials, equipment and labor. Similarly, many foundries are suffering from an acute shortage of manpower, particularly "unskilled" labor (and even have trouble convincing the right people that very little of the labor

RYERSON STEEL-SERVICE



Ryerson now interprets modified Jominy Test results in terms of quenched and drawn physical properties for 1, 2, 3, and 4-inch round alloy steel bars.



RYERSON ALLOY STEEL REPORT

(For Jominy Test interpretation see reverse side)

This report contains the analysis submitted by the mill, for the heat of steel used to fill your order. The Jominy Tests and physical property interpretations are made in the Ryerson Laboratory. This data is subject to normal variation due to segregation, etc.

Order No. ____ Date ____

IDENTIFICATION

Type ____ Heat ____

Steel ____ Symbol ____

Color ____

Marking ____

Jominy End Quench Hardenability Test Results

COOLING RATE, in deg. F. per second

ROCKWELL HARDNESS "C" SCALE

DISTANCE FROM WATER COOLED END OF STANDARD BAR

Heat Analysis

Carbon ____ Mang. ____

Phos. ____ Sul. ____

Sil. ____ Nil. ____

Cr. ____ Mo. ____

Grain Size ____

Working Temperatures

Quench ____ °F. ____

Anl. ____ °F. Norm. ____ °F.

Forge ____ °F. ____

Physical Properties as Interpreted from Jominy Tests

Quenched in ____ at ____ °F. and drawn as shown.

Size of Round	Temperature of the Draw	Tensile Strength P.S.I.	Yield Point P.S.I.	% Elongation in 2 Inches	% Reduction of Area	Brinell Hardness
1 Inch Round Center						
2 Inch Round ½ radius						
3 Inch Round ½ radius						
4 Inch Round ½ radius						

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New Data on Alloy Physicals

Ryerson furnishes hardenability interpretations with each alloy steel shipment

The new Ryerson Alloy Steel Report sheet is furnished with each shipment of alloy steels from stock. This report includes: a positive identification for the steel you receive . . . its chemical analysis as reported by the mill . . . the recommended working temperatures of the steel . . . a chart of its hardenability response with interpretations of the physical properties *after* heat treatment and the effect of mass on the physicals of 1, 2, 3, and 4-inch bars.

All this information makes it easier for you to specify your alloy steel requirements in terms of *what the steel will do* . . . rather than on analysis alone. It further guides you in the proper heat treatment of your steel to obtain the best results.

Ryerson engineers and metallurgists will gladly assist you in any problem of steel selection, application or fabrication. Investigate this helpful service next time you need steel from stock.

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RYERSON STEEL–SERVICE

around a foundry *is* unskilled to begin with).

Our concern with the matter rests only incidentally in the unfortunate "profit" position in which gray iron foundries are left. It rests primarily in the cold statistics that the 1943 output of the industry is expected to be only 12.5 million tons of gray iron as against 14.5 million tons for 1942 and that many shops are operating considerably below capacity. This unfilled gap represents just so many tons of war equipment that might have shortened the struggle but which was never made. That's the reason we want to see foundries (all other plants, too, for that matter) as busy as possible.

This partial inactivity has many causes—revisions in types or numbers of military equipment; a slackening of the machine-tool building orders; the closing of an occasional foundry because each casting it made meant merely so many dollars lost; inability to obtain enough workers to maintain operations at or near capacity; and a possible tendency on the part of designers to slight gray iron castings when selecting materials or forms to be manufactured. There were hints from the government speakers at the meeting that the immediate future may bring some lifting of the gray clouds over gray iron. But it looks as though the industry, in the largest sense, must help itself, and its Society has already made great strides in this direction.

Better engineering in individual foundries will certainly help in achieving lower operating costs and in getting the most out of available manpower. Better cost accounting (towards which the Society already lends much aid to its members) will avoid the inaccurate and profitless pricing that has crippled some shops and harmed the whole industry. Better education of the specifying and buying factors in the fields that consume iron castings and competitive materials will help to turn a fair share of the market toward gray iron.

For gray iron—as we have repeatedly declared—is today an engineering material on a par with steel forgings, steel castings, non-ferrous castings and other forms for many applications, and for certain jobs (especially those requiring highest damping qualities, superlative machinability or lowest production cost consonant with adequate quality) it is unquestionably superior. These are indeed the brightest spots in its present and future position—the fact that gray iron's mechanical quality is now generally high, that the best-informed engineers already realize this and that further education of the rest of the consuming field to the advantages and limitations of gray iron will undoubtedly place it in a strong post-war competitive position.

—F. P. P.

Two Buckets

In pre-war days it was possible to buy an ordinary galvanized bucket for about twenty-five cents. It was a good bucket too — it didn't leak, it didn't rust, it was fairly strong, it was easily cleaned, it looked — well, not beautiful, but presentable. All told, a good bucket.

With metal supplies for civilian use sharply reduced, and many metal articles "out for the duration," things formerly made of metal are being reproduced in some substitute material. The plastics, wood, paper, glass, and many other materials are being adapted to these uses. The old oaken bucket has reappeared.

Wooden buckets have a long history. The trade of cooper is an old and honorable one. It requires a degree of skill and experience to make a watertight barrel or bucket of wooden staves, formed and fitted together without calking, tight enough to contain water. But it isn't a really good bucket. It's heavy. It tends to leak if it has dried out thoroughly before being put to use. If placed in the sun, it may warp beyond repair. It is cleaned with difficulty. And it will cost about seventy-five cents.

There is something here for metal industries to consider. The metal bucket replaced the wooden bucket because it was a better, cheaper bucket. Wooden buckets may stage a temporary revival under necessitous circumstances, but it seems unlikely that they'll come back permanently. The "economics is agin it."

The same laws will apply to other materials which have invaded the metals field as wartime substitutes. Those that can supply a better, cheaper or in some way more satisfactory article will very likely stay. Those that can't will disappear with the wooden bucket.

Metals have many advantages over most of today's substitutes. They are strong, even in thin sections. They are easily worked in an amazing variety of ways. They can be finished attractively. They are durable. Now that the mysteries of alloying are understood and controlled, a composition can be produced for almost any required set of properties. We may see some shifting about in the materials groups, and perhaps some substitutes may remain, but it is hardly likely that the metals, which have so much to offer, will suffer in the final balancing of accounts.

—K. R.

Forming Heavy Plate on a 6000-Ton Press

By GERALD E. STEDMAN

The characteristic American urge to produce "the biggest yet" is responsible for much of our industrial progress. For example the hydraulic press described in this article is not only the world's largest plate bending press (according to its owners) but is also to be credited with noteworthy achievements in saving fabrication time and boosting vessel sizes and steam pressures. —*The Editors*

THE WORLD'S LARGEST PLATE bending press is in operation at the Chattanooga plant of the Hedges-Walsh-Weidner Division, largest of five manufacturing components of the Combustion Engineering Co., Inc., New York. This "Big Press" is capable of cold bending boiler plate up to 6 in. or more in thickness and in lengths up to 40 ft. Its overall dimensions are 55 ft. wide, 49 ft. high (22 ft. of the latter below ground). It exerts a total pressure of 6000 tons. In the old days, it required 30 days to cold roll and form press a boiler shell for riveted construction. This huge press, by hot forming, has reduced fabrication time to four days.

The Combustion Engineering Chattanooga plant produces boilers of all types and huge sizes, fabricated products, bubble towers and pressure vessels. Other C-E divisions manufacture a complete line of mechanical stokers, mills and burners for pulverized coal firing, superheaters, economizers and air preheaters, special equipment for chemical recoveries and by-product steam generation in pulp mills and sewage incinerators.

The Combustion Engineering Co. is now "all out" in war production. Its stationary and marine unit steam generating equipment, known as "Victory Units," are already supplying 40,000,000 lbs. of steam per hour for navy yards, munitions, arsenals, ordnance, army and navy bases, synthetic rubber, high octane gas, maritime commission ships (Liberty), and naval vessels (Destroyer Escort). These installations alone represent a rate of steam output sufficient to serve about 13 per cent of the total fuel generated kilowatt capacity of all the public utility plants in the country.

By the prowess of this big press, the C-E Chattanooga plant has arrived at vessel diameters from 20 in. to 12 ft. 0 in., and lengths from a few feet to over 50 ft.; boiler pressures up to 2,000 lbs. per

sq. in., and boiler plate thicknesses over 6 in. In the old days of riveted boiler construction, 2½-in. thick shells were about the limit, for they required a rivet grip of 7 in. with long butt straps inside and out. The demand for higher pressures caused much research in the late '20s in which A. J. Moses, vice president and general manager, Chattanooga C-E plant, played a leading part.

The development of a fusion welding technique and satisfactory non-destructive testing by radiography caused a revolution in boiler making, signaled by the A.S.M.E. Code Committee approving the first welded boiler in 1931. This was a C-E product. The development of the 1,000,000 volt X-ray unit, one of the first of which was bought by the C-E Chattanooga plant, and, in 1937, the installation of the big press, have created a complete revolution in boiler design and fabrication.

Press Construction and Operation

The C-E big press consists of two 3000-ton, 4-post hydraulic presses connected by two built-up beams. The Baldwin-Southwark Division of the Baldwin Locomotive Works built the presses and controls in accordance with C-E design and construction. The two presses operate on a 1500-lb. line pressure from the accumulator, intensified to a 3000-lb. per sq. in. hydraulic water pressure to exert the total pressure of 6000 tons. The main features are: (1) The presses, (2) the beams, (3) intensifiers, (4) accumulator, (5) foundation, (6) dies, (7) controls.

The foundation for press and intensifier units is approximately 25 ft. by 75 ft. by 24 ft. It required 1,932,000 lbs. of poured concrete, as well as 70,000 lbs. of reinforcing steel, anchor bolts and floor plates. Since the foundation had to rest on quick sand, it necessitated an apron to confine the quick sand. The press sits on a foundation of piers in this pit. The upper movable beam is 52 ft. long, 14 ft. deep at the center section, and weighs, including male dies and attachments, 474,120 lbs. The lower beam with its female dies and attachments weighs 423,540 lbs. It is 10 ft. from the face of the base casting to the bottom of the pit. Twelve 2½-in. foundation bolts anchor each press.

The two main rams are 52 in. in dia. and operate at 1500 lbs. pressure, which can be intensified to 3000 lbs. There is 13 ft. of daylight between the base and the ram. There are 4 pull-back rams per press for high speed return. These pull-back cylinders are 16 in. in dia. The lower die is equipped with four manipulating rams 8 in. in dia., which facilitate handling of the work. Four equalizing rams, 8 in. in dia., keep the top girder thoroughly horizontal through the whole stroke. The intensifier is a dual piston arrangement, having a small ram on one and a large ram on the other. The low pressure cylinder comes under the low press ram. Having twice the area of the opposing ram, it doubles the pressure going to the press. The total pressure of 6000 tons is thereby achieved.

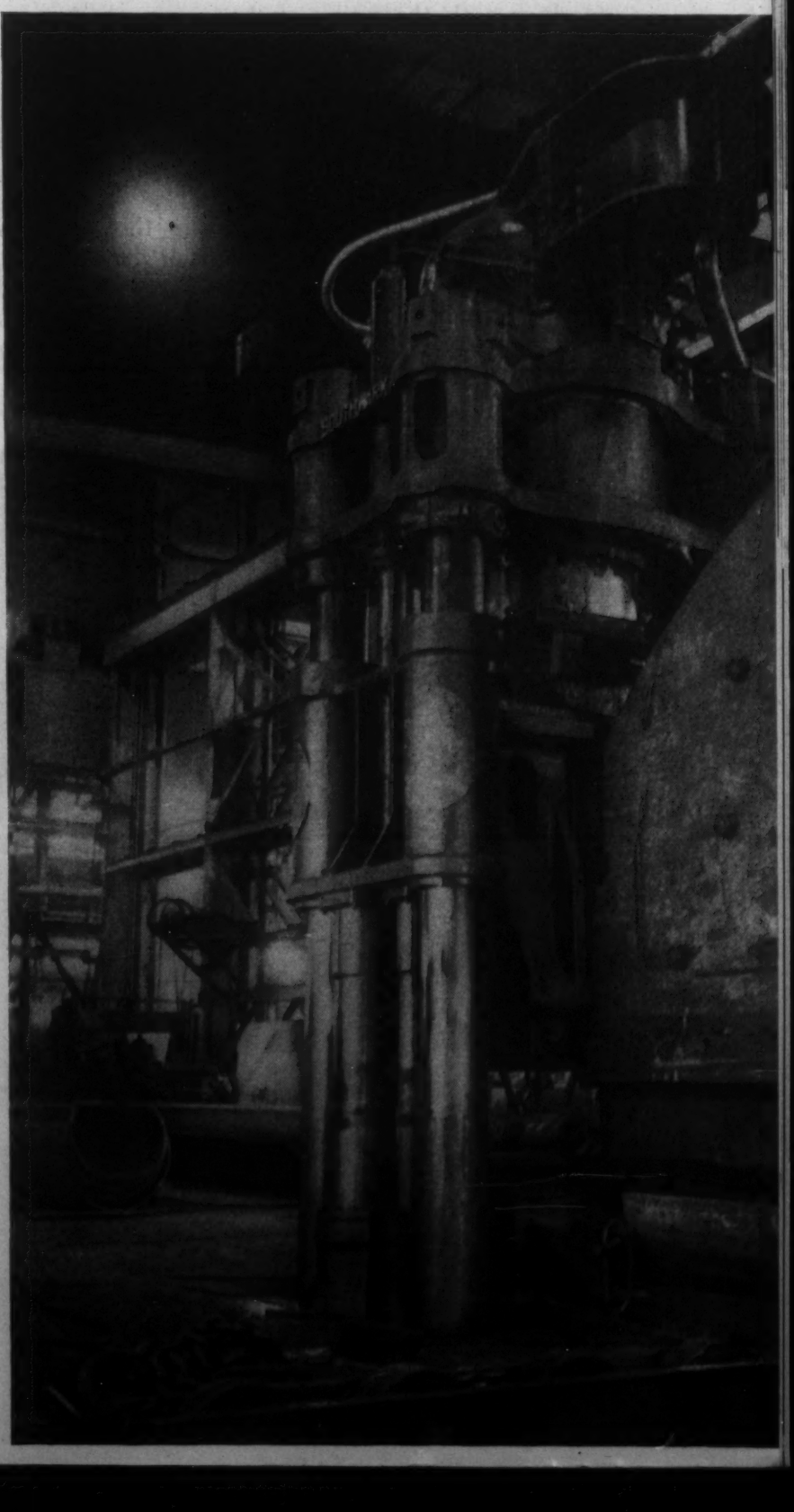
The water filling tanks are located in the pit and connected with the press members. They operate at 100 lbs. air pressure. These are used to fill the cylinders before admitting high pressure water. The latter is used for the squeeze.

The bottom girder of the press is made up of 10 2¼ in. plates, 14 ft. 6 in. wide x 56 ft. long. The top beam is composed of 10 2-in. plates, 14 ft. 6 in. wide x 56 ft. long. The top girder is of the full-floating type, restricted only in the transverse direction. Since it was impossible to buy plates of the required width, the beams are of C-E welded construction—two plates 7 ft. 3 in. joint welded, X-rayed, stress relieved in C-E shops. The girders are of the "fish belly" type.

Two sets of form blocks are used to handle all thicknesses of plate bending: (1) From 36 in. up to any radius, (2) 18 in. to 36 in. Odd dies are at hand for special jobs such as tapered shells, small diameters being often accomplished at one stroke of the press. The stroke is 60 in.

The Controls

One of the significant features of the big press is its controls. A single operator standing at a conveniently located battery of valves in full view of the



One end of the 6,000-ton press.

A hot plate on the car just taken from the heating furnace.

work controls the action of the press and plate manipulators. In spite of its extraordinary size, it operates simply and fast. Valves are so arranged that the operator applies 1500 lbs. pressure, which develops 3000 tons and he can then immediately apply the boost of the intensifier to gain the 6000-ton pressure.

C-E uses 75-ton cranes to service this big press and these cranes are an integral part of the processing technique, the crane holding up one edge of the work during forming. Manipulators on the press assist in locating the plate. These manipulators are hydraulic, come up through the bottom of the dies, and are of C-E design. The dies are ship lapped on their edges and are held down by clamps.

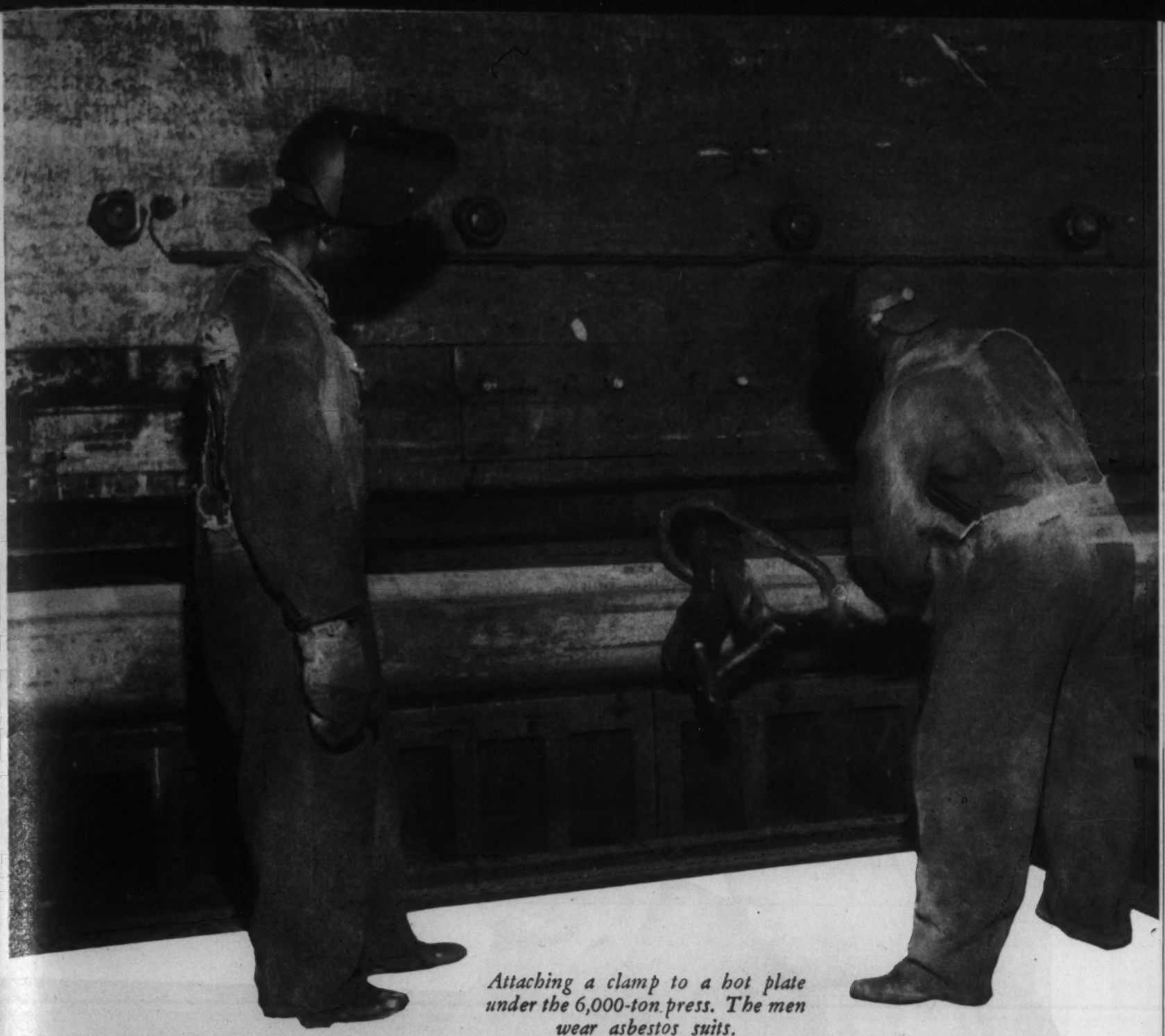
Steels Used and Heat Treatment

The company uses modified carbon steels for welded pressure vessels of heavy wall thickness, having a 70,000-lb. per sq. in. minimum tensile strength. The carbon and manganese content of these is higher than ordinary 55,000 lbs. tensile fire box steel, the carbon range being limited to 0.35 and the manganese to 0.90 per cent maximum. A third alloy steel is in favor for pressure vessels operating at high temperature. This is a carbon-molybdenum steel containing 0.20 C, 0.60 Mn, and 0.50 per cent Mo, and has a minimum tensile strength of 70,000 lbs. per sq. in. at room temperature.

Boiler shells are formed in two sections whose complement must naturally be 360 deg., though each section may vary away from 180 deg. They are joined by two longitudinal, fusion welded seams. Unequal plate thicknesses between sections are frequently welded for economy; using a thicker plate for surfaces perforated with tube holes, a lighter section plate for sections having greater ligament efficiency or being unperforated entirely. In such cases, after forming on the big press, heavier plate sections are tapered to the lighter section thickness—neutral radii being made equal and neutral circumferences coincident.

As the plate thickness increases, because of the ratio of reduction and lower grain refinement in rolling, they do not receive as much mechanical work at the mills. All plates above 2 in. by A.S.M.E. specifications, require a normalizing treatment for grain re-

Cold forming a heavy plate under the 6,000-ton press.



Attaching a clamp to a hot plate under the 6,000-ton press. The men wear asbestos suits.

finement before forming. This is applied on the flat plates, the heat treatment subjecting the steel to a temperature slightly above the upper critical range, holding the heat for one hour per inch of thickness. Plates so normalized are specified with slight extra thickness to compensate for scale loss. The normalizing temperature is 1650 to 1750 deg. F.

Cold and Hot Forming

It is next to impossible to tabulate plate pressing formulae as there are too many variables to be considered. As a general rule, C-E does not cold press plate over 2 in. thick. By intermediate stress-relief between cold bending operations, the plate can be formed to as small diameter as desired. C-E has bent 2-in. plate 12 in. i.d. Above 2 in., as later described, plate is normalized and hot-pressed to near the finished diameter required.

There is considerable difference of opinion as to thickness of plate that can be bent under this 6000-ton press. C-E feels that any thickness can be pressed that will go between the dies, as it does not coin the plate but increases or decreases the power by the span of the dies and the size of the area on which the load is concentrated. The time factor goes up rapidly as thickness and length increase, reaching a point economically prohibitive.

An interesting feature of the big press technique is that C-E utilizes this normalizing heat to hot-form and then, with temperature loss to perhaps 1000 deg. F. in the forming strokes, the plate is removed from the big press, stress relieved and finished cold, depending upon the elongation required. The method is to hot-form to the point which will reduce to a minimum the amount of cold pressing. It is necessary in the hot forming procedure to watch the scale, preventing it from embedding, by blowing it off and cleaning with an air hose. The bi-axial stresses involved in the bending of plates cold in great widths do not permit of cold bending to the same degree of elongation of outer fibres as is permissible in the bending of narrow test specimens. The greater the elongation of outer fibres required, the more frequent

interstage stress relief is required. There are close rules and formulae governing the degree of elongation of the outer fibres of the plate in cold bending before interstage stress relieving.

In working the heavier plates, the practice is to use a narrower upper die and a wider bottom die, avoiding the error of having the upper die so narrow as to indent the plate. This method requires more press strokes. After the original hot-forming, making use of normalizing temperature, the cold finish forming is interrupted by interstage stress relief because cold working of such heavy plates sets up stresses.

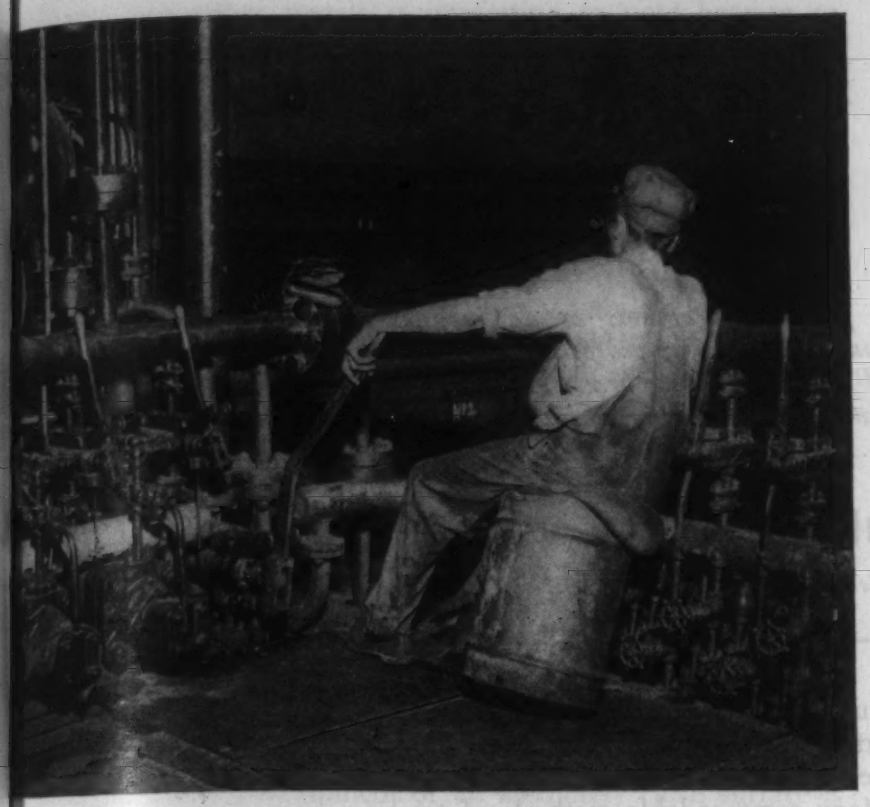
Heat-Treating Furnaces

C-E uses two heat-treating furnaces in connection with the big press. The normalizing furnace, 14 ft. x 45 ft. x 11 ft. is a car-type chamber, its height clearing the top of car by 7½ ft. This permits quick removal, thus making normalizing heat more utilizable in hot forming. The furnace is used for stress-relief of boiler drums as well. Rectangular baffled combustion troughs for oil firing are located in the floor. Combustion chamber outlets are on lower sidewalls, below car level. Thermocouples at four critical points provide automatic temperature control.

After forming, the waste on the edge of the plate must be trimmed. It is impossible to press to the full radius, causing this waste edge which is burned off with oxyacetylene. The finish operations on the separate sections, preparatory to welding operations, is the milling of the weld groove and the planing of the taper on heavy sections. Some sections are planed before forming. Similar machining of shell thickness down to head thickness and preparation of girth weld grooves usually is done after the completion of the longitudinal seam welding.

All welding is done by the electric arc method, using heavily coated electrodes of C-E composition and production. The double-butt type of weld joint is used on all main seams; fillet welding is permitted only in welding nozzles, reinforcements, internal and

Taking the curvature of a plate after cold forming.



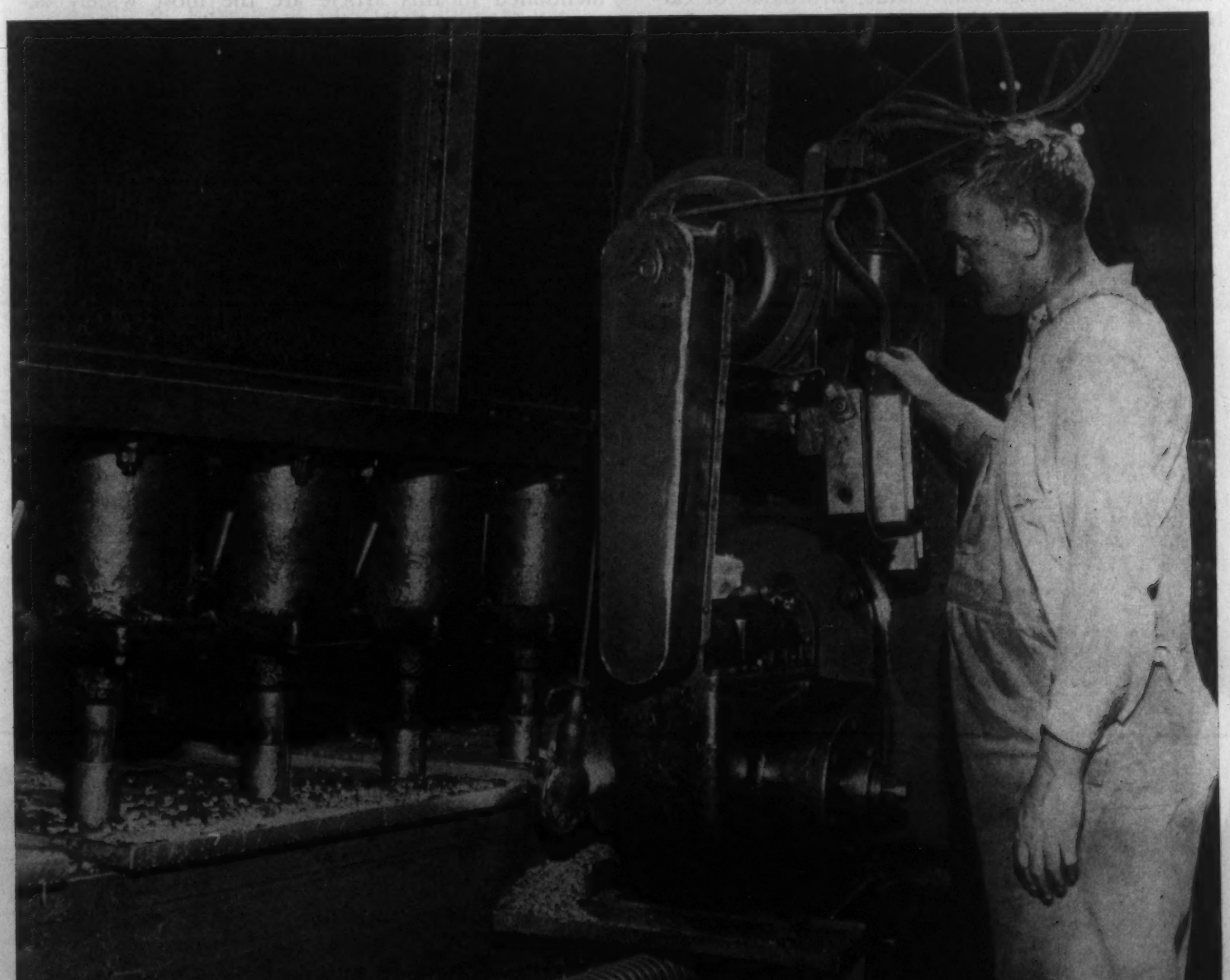
Operating controls of the 6,000-ton press.

external attachments. All welding is down-hand, the drum being rotated in girth seams. All main seams are radiographed—from 8 to 15 lineal inches of weld joint being X-rayed per exposure.

A Triumph in Plate Bending

The big press is a triumph in plate bending and forming. It produces the highest grade of workmanship so far originated and with substantial reductions in time. The method of hot forming, using the normalizing heat, has in itself reduced the time factor over cold forming, better than 34 per cent. Thicknesses in construction and consequent pressures have been increased beyond limits previously possible.

In truth, the limiting factor is no longer a matter of forming, but of non-destructive test limitations. The company feels that the limiting factor of boiler plate thickness of satisfactory quality is now the problem of the steel maker. With the critical searching eye of the C-E million-volt X-ray equipment, it is felt that this company is prepared to satisfactorily produce and non-destructively test pressure vessels of wall thicknesses far in excess of those now available in quality boiler plate material.



illing the
ate ends.

Surface Treatments for Magnesium

Part I

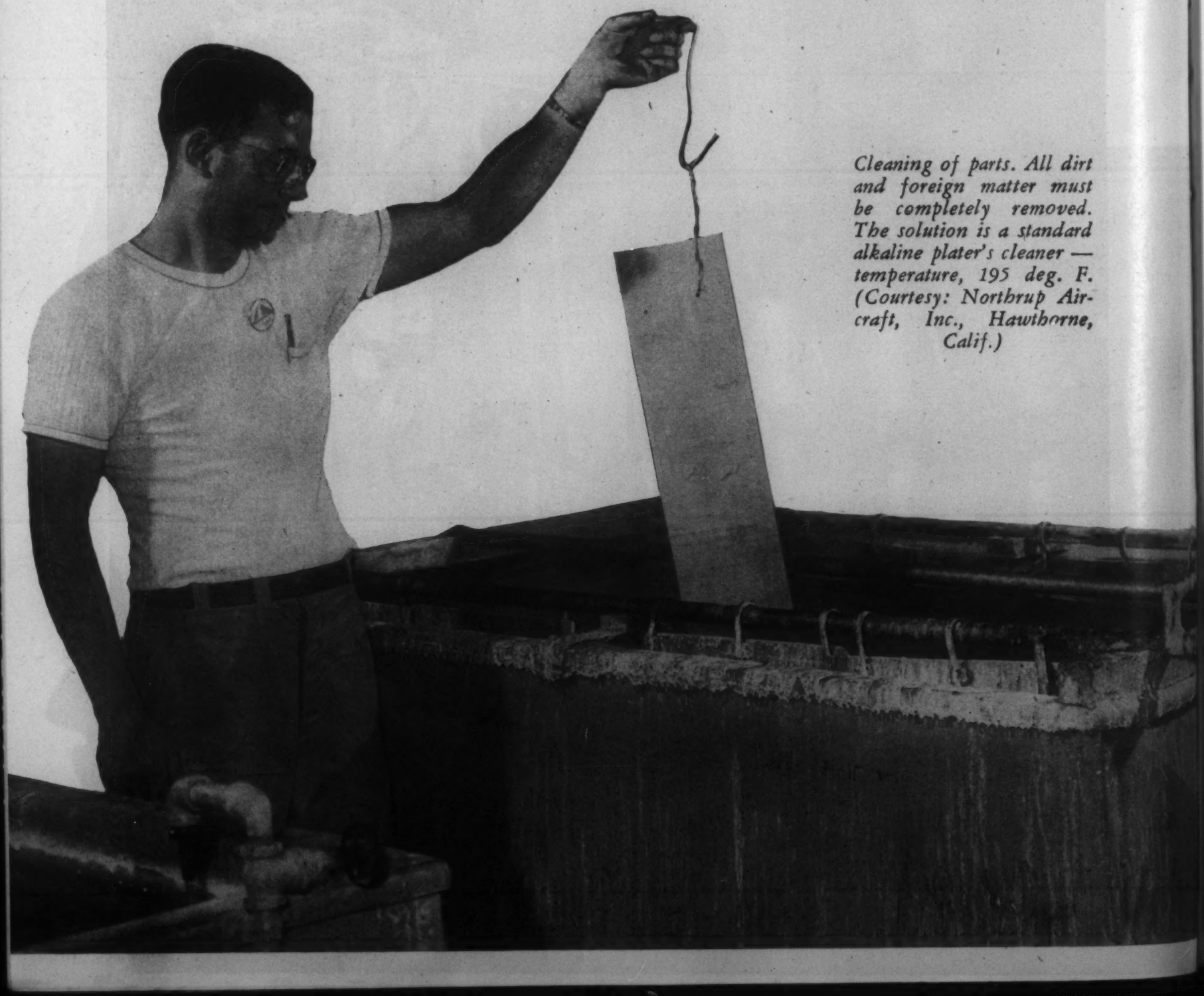
Few industrial materials require as much attention to finishing problems as do magnesium alloys, for virtually all aircraft and other parts made therefrom must be given a protective coating of some type to improve their corrosion resistance. A number of useful treatments and practices have been employed for this purpose, and in this article the various processes, baths and operating conditions are described and discussed in helpful detail.
—The Editors

By EMMETTE R. HOLMAN and JAMES P. ApROBERTS

Technical Dept., Turco Products, Inc., and Chemistry Dept., Triplett & Barton, Inc., respectively, Los Angeles, Calif.

AS THE CONSUMPTION AND PRODUCTION of magnesium increase, more attention will necessarily be given to its processing. This will be somewhat for decorative reasons but chiefly on account of protective requirements. Upon exposure, a naturally protective film of magnesium oxide, hydroxide or carbonate is developed on the metal's surface according to the conditions encountered. The security which this film affords is not considered adequate for those articles which may, as in the case of aircraft parts, be subjected to a variety of service conditions. Many commendable methods of treating magnesium have been or are being developed. At present those mentioned in this article are the most widely accepted and specified.

The relation between the finishing of magnesium



Cleaning of parts. All dirt and foreign matter must be completely removed. The solution is a standard alkaline plater's cleaner — temperature, 195 deg. F. (Courtesy: Northrup Aircraft, Inc., Hawthorne, Calif.)

and other metals is interesting to note because so much of the average plating shop's equipment can be used — such as hot and cold tanks, rinse tanks, racks, generators and ventilating devices. Since the present status of magnesium is closely related to the war effort, persons processing it should have little difficulty in securing any special chemicals or equipment which may be needed. Special controls for temperature and current are sometimes specified for operating conditions. The chemicals which are mentioned in connection with these treatments may be of technical grade provided that due allowance is made for the lower percentage of active ingredients and the heavy metal salts content is kept at a minimum.

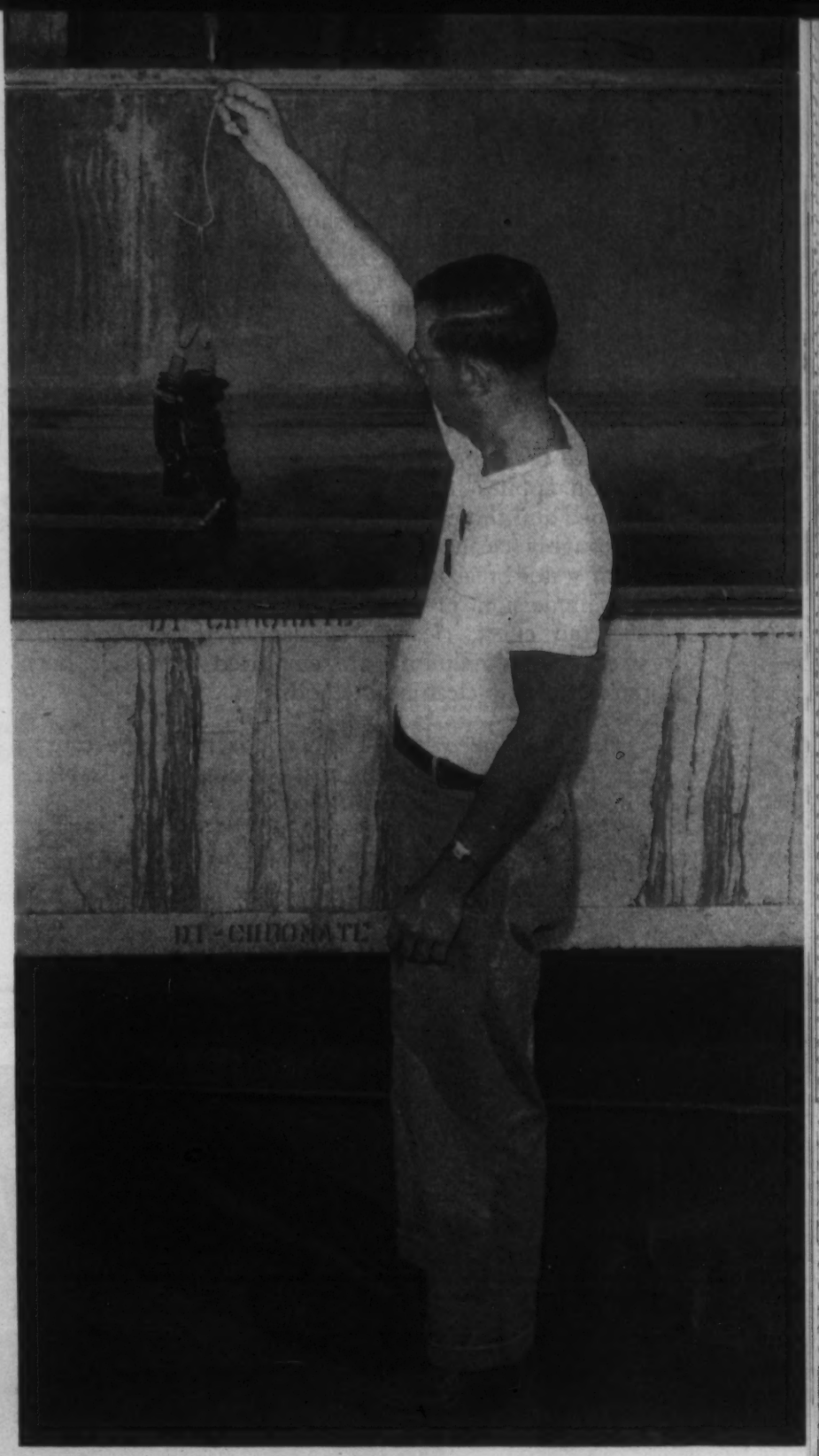
The personnel of the average metal finishing plant should be capable of doing this type of work. The skill and experience which they have already secured through treating other metals in similar processes should make them especially well qualified for handling magnesium.

Pretreatment Methods

The development of an absolutely clean surface is an especially important consideration in the successful treatment of magnesium parts. This is because the adherence of subsequent protective films is dependent upon grippage effected throughout the entire surface. This in turn must mean complete removal of all foreign matter, not only such ordinary contaminants as cutting or forming oils, but also any natural films which would interfere with the ability of the treatment applied to form a continuous bond with the metal's surface.

Cleaning may be done by mechanical or chemical methods. Typical *mechanical methods* of cleaning are sandblasting, shotblasting, wire brushing and sanding. Though they are efficient, partially because of the softness of the work's surface, they do have the disadvantage of removing a certain variable amount of base metal and at the same time contaminate the surface by imbedding minute impurities in it whose presence lowers the corrosion resistance of the work. For this last reason, mechanical surface preparation should be followed by the removal of between 0.002 in. and 0.006 in. of surface by pickling in Solutions I or III (described under "Pickling," below). Hence this class of cleaning is generally limited to treatment of rough unmachined surfaces.

Chemical methods of cleaning depend to a certain extent upon the contaminants encountered. The three steps, precleaning, cleaning and pickling, comprise a typical chemical cleaning cycle. Precleaning in this particular instance is often necessitated by the use of casting mold lubricants such as cocoa butter whose high melting temperatures and affinity for magnesium make their elimination difficult. The removal of such impregnated matter as well as heavy films of oil or grease and other difficultly soluble contaminants by a single cleaning operation often requires too much time to produce the essential degree of cleanliness previously mentioned. Hence, precleaning by one of the methods described below may be justified.



A dichromate tank. Parts are boiled in this sodium dichromate tank for 45 min. This gives the final protection finish. (Courtesy: Northrup Aircraft, Inc., Hawthorne, Calif.)

Cleaning

Precleaning usually requires an average time of 5 min. Two types of precleaning are in wide use:

1. Solvent (Vapor degreasing):

   When organic solvents are used in magnesium cleaning, a final rinse in clean unused solvent must be included.

2. Emulsion (Special precleaning materials — emulsifiable solvents):

   This operation is followed by a thorough cold water rinse.

Conventional degreasing equipment or precleaning hot tanks may be used for the above step. When

operating degreasers, care should be taken to see that the degreasing solvent is kept as clean as possible and the accumulation of appreciable quantities of oils and dirt in the machine is avoided. When precautions such as the above mentioned are taken, precleaning will accelerate the cleaning cycle and prolong the effective life of the principal cleaning solution.

Final Cleaning: The final or principal cleaning operation applies both to parts which have been precleaned and those with an ordinary degree of soil. A thoroughly cleaned surface is indicated by freedom from water breaks (a continuous water film) following immersion in clean cold water. To produce such an effect, cleaners similar to those used on steel (not aluminum) are employed in either hot tank or electro-cleaning methods.

A. Electrocleaning: The work is made the cathode. Temperatures near boiling are usable. Current density is between 10 and 20 amps. per sq. ft. at 6 or more volts. Usual operating time necessary is 1 to 3 min. Ordinary racks appear to be satisfactory.

B. Still tank cleaner:

1. Work is completely immersed in a boiling alkaline cleaner. Cleaning time varies between 5 and 15 min. according to type and quantity of contaminant to be removed. Agitation is advisable especially if boiling temperatures cannot be steadily maintained.
2. Hot water rinse (140 to 180 deg. F.)
3. Cold water rinse. Cooling down instead of drying the work by a final hot rinse will eliminate the tendency for carried over solids to dry on and cause a whiskered appearance.

Typical cleaning solutions are:

A. Electrolytic (or boiling) baths:

Trisodium phosphate	4 oz.
Sodium carbonate (soda ash)	4 oz.
Water to make	1 gal.

B. Boiling (non-electrolytic) Baths:

Sodium carbonate (soda ash)	3 oz.
Sodium hydroxide (caustic soda)	2 oz.
Soap	1 oz.
Water to make	1 gal.

The hydrofluoric acid dip. Parts are dipped for 5 min. in a water solution of 15 to 20 per cent hydrofluoric acid and then washed. (Courtesy: Northrup Aircraft, Inc., Hawthorne, Calif.)

Table I. Commercially used pickling solutions for magnesium alloys.

Method	*Bath*	*Operation*
Nitric-Sulphuric Pickle (For mechanically cleaned and unmachined parts only).	Conc. nitric acid... 8% by vol. Conc. sulphuric acid ..... 2% by vol. Water .....90% by vol.	Solution is used cold. Immersion time — 10 to 15 sec. It will remove 0.002 to 0.006 in. per surface of metal. Depletion is indicated by decreasing activity. Bath may be considered exhausted when its ability to remove obstinate scale within a reasonable period of time (30 sec.) is lost. It should then be replaced with a fresh solution.
Chromic Acid Pickle[3] (Nonetching, may be used on machined parts).	Chromic acid .....24 oz. Water to make ..... 1 gal.	Solution is operated at 180 deg. F. and above; immersion time is 1 to 5 min. In using water solutions of chromates the soluble chlorine content of the make-up water should be kept at a minimum (350 ppm. or less).[2] If it is apt to contain more than this amount, it should either be treated with approximately 0.1 per cent of silver nitrate in a water solution to remove chloride interference of chlorine-free water should be obtained.
Sulphuric Acid Pickle (For mechanically cleaned and unmachined parts only).	Conc. sulphuric acid ...4 oz. Water to make .....1 gal.	Solution intended for treatment of sand castings following sandblasting and prior to subsequent processing. Work is immersed at room temperature for a length of time sufficient to remove 0.002 in. of metal per surface. When the solution is in good working order from 30 to 90 sec. will be required. If this is not the case, more acid should be added as determined by a method furnished by the magnesium suppliers. Work is immediately rinsed. A loose gray powder may be deposited on the work, especially surfaces of castings. It is removed by subsequent chrome pickling.

Table II. Surface Treatments Used for Finishing Magnesium Alloys.

Common Name	*American Magnesium Corp. Designation*	*Dow Chemical Co. Designation*	*Specifications*	
			U. S. Army	*U. S. Navy Aero.*
Chrome-Pickle	AMC A	Dow No. 1	98-20010-B Par. E-3A	M-303b with Amendment 1
Acid-Dichromate	AMC G	Dow No. 7	98-20010-B Par. E-3B	M-407 with Amendment 1
Alkaline Dichromate	AMC H	Dow No. 8	Acceptable on request	M-382
Anodic	——	——	——	PT-13d
Galvanic Anodizing	AMC K	Dow No. 9	——	M-395 with Amendment 1
Sealed Chrome Pickle	AMC L	Dow No. 10	——	M-406a

Proprietary Cleaners: The use of proprietary cleaning solutions developed for magnesium cleaning by either hot tank or electrolytic methods is not to be underestimated. Not only does the user secure carefully compounded materials but he also obtains the advantages of special ingredients such as wetting agents which noticeably improve cleaning technique and afford a wider latitude of make-up water conditions plus longer solution mileage.

Electrolytic versus Still Tank Methods of Cleaning: In contrast to still tank methods, electrolytic cleaning is more rapid and can be done successfully at lower than boiling temperatures (180 deg. F.). Vigorous agitation is provided by gas evolution on the work's surface.

Solution conductivity upon which the efficiency of electro-cleaning is principally dependent can be increased by using a more concentrated solution of cleaning compound. Shorter electrode distances and higher operating temperatures will also increase conductivity and hence cleaning efficiency. The difference in time required for the two methods is another factor not to be overlooked when planning for production.

Pickling

Pickling or oxide removal is the final step after cleaning in a suitable alkaline cleaner in the surface preparation of magnesium prior to actual application of protective treatments. This appears to be best accomplished by the use of certain acid solutions. Though several acids will dissolve the oxide film, the action of many of these is not selective, for as soon as the oxide film is dissolved, the attack will continue into the base metal unabated. The solu-

tions described in Table I have been found to be satisfactory for this operation and are in common use.

Sanding: It should be noted in the case of thin sheet stock which may be spotted with oxides, oxide removal can consist of rubbing out the oxidized sections through sanding which is followed by thoroughly wiping with the above chromic acid solution and subsequently rinsing.

Rinsing: Following each of the treatments outlined in Table I the work should be first rinsed in cold and then hot water to eliminate interference with subsequent operations.

Chemical Surface Treatments

Actual finishing operations differ according to the type of treatment specified. The treatments most commonly used are presented in Table II.

The "Chrome Pickle": the first mentioned treatment is widely used as a protective treatment during storage, shipping and subsequent machining operations. It is also effective as a paint base and is sometimes used as an etching pre-treatment similar to Solution I described under "Pickling."

Following cleaning, the work is dipped in a chromic-nitric acid solution which may be made up of either sodium dichromate or chromium trioxide ("Chromic Acid") as follows:

(1) a. Sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$) . . . 1.5 lb.
Conc. nitric acid (Sp. Gr. 1.42) . . . . . 1.5 lb.
Water to make . . . . . 1 gal.

(2) b. Chromium trioxide (CrO_3) . . . . . 1.0 lb.
Conc. nitric acid (Sp. Gr. 1.42) . . . . . 0.9 pint
Water to make . . . . . 1 gal.

The time for treatment varies according to solution temperature and the alloys processed. At room temperature (70-90 deg. F.) for ordinary alloys this is ½ to 2 min.; for die castings of 10 to 12 per cent alloy, bath is operated for 10 sec., or slightly longer at 125-135 deg. F. Following this the work is exposed to air and allowed to drain for 15 sec. before receiving a thorough cold water rinse followed by a final hot water dip to facilitate drying.

Satisfactory operation is indicated when coatings obtained are matte gray to yellow, with red iridescent shades predominating. Signs of depletion are decreasing solution activity, shallow etching and paleness of color. In this connection, bright and brassy coatings are to be avoided. Control is based upon chromate or chromic and nitric acid contents as indicated by chemical analysis.

The "Sealed Chrome Pickle": After "Chrome-Pickling" parts, especially die castings, improved corrosion resistance may be obtained by a 30-min. immersion at room temperature (70-90 deg. F.) in a solution of 1 to 2 lbs. of sodium potassium or ammonium dichromate per gallon of water; a pH of 4.0 to 4.4 is maintained by additions of chromic acid. The pH is measured by electrometric methods.

Properly treated articles appear to have a matte iridescent finish with yellow and red shades predominating. Bright yellow coatings indicate an excess of nitric acid which can be avoided by additions of sodium dichromate.

The "Acid Dichromate" Treatment: The acid dichromate treatment is the most popular treatment for magnesium. It offers superior salt water corrosion resistance but the coating is softer and hence less abrasion resistant. It produces dark brown to black coatings, depending upon the time of treatment, bath condition and alloy composition. It produces no dimensional change and, furthermore, brass, bronze, and steel (but not cadmium or aluminum) inserts are unaffected. Dowmetal M or Mazlo AM3S or other high manganese alloys may not be treated by this process.

The work is first cleaned as above described after any previously applied coatings have been stripped by immersion for 10 sec. in solution No. 1. (Nitric Sulphuric Pickle) at room temperature (70 to 90 deg. F.) *before machining* to avoid a non-uniform appearance. Immediately after machining, the parts are again cleaned as previously described and then immersed for 5 min. in the 15 per cent hydrofluoric acid bath at rom temperature (70 to 90 deg. F.).

Hydrofluoric Acid Bath: The composition of the hydrofluoric acid bath is as follows:

Hydrofluoric acid (48 to 52%) . . . 1 part by volume
Water . . . . . 2 parts by volume

This bath is slowly depleted. The hydrofluoric acid bath concentration should be maintained, by titration, at a concentration not less than 10 per cent in order to avoid any etching action likely to occur in weaker hydrofluoric acid solutions.

Note: Regardless of concentration, hydrofluoric acid solutions should be handled with care. This means extreme caution in manipulating work in such solutions, ample ventilation and using lead, rubber or "synthetic" lined tanks. Any flesh burns (which may result from failure to use rubber gloves and wear protective clothing) or breathing difficulties should be treated immediately. The former requires thorough and prolonged washing in cold water and in either case call a physician if a serious burn is indicated by pain, loss of sensation or redness of the skin.

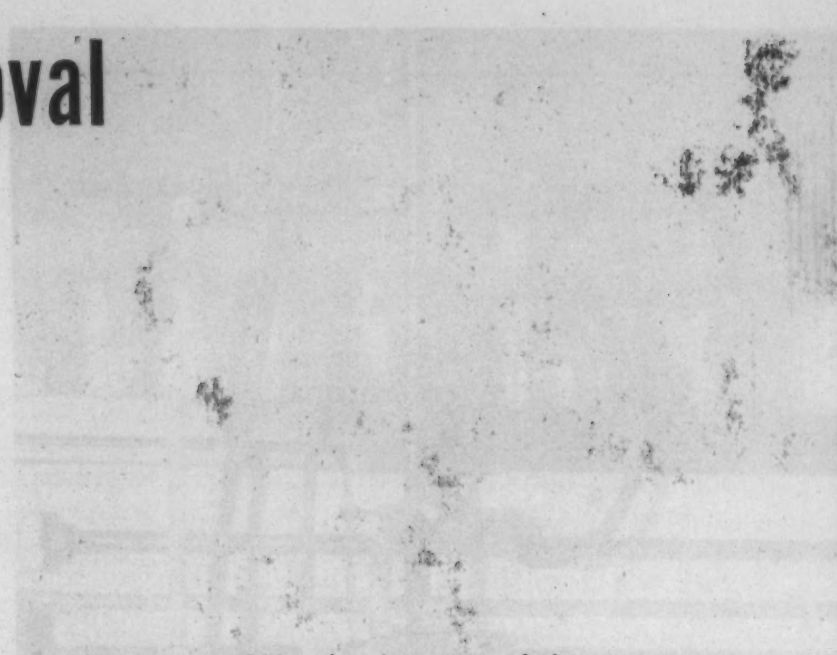
Following the hydrofluoric immersion and rinsing operations, the work is boiled for at least 45 min. in a 10 per cent sodium dichromate solution composed of ¾ lb. of technical sodium dichromate per gallon of water. During operation, this solution will tend to become more concentrated by evaporation. Hence water should be added to make up for such losses. Following this, the work is first rinsed in cold water and then given a drying dip in hot water.

The pH of the solution can be measured by electrometric methods and is maintained between pH 4.5 to 5.5 by the addition of a 10 per cent solution of chromic acid.

After the hot dichromate treatment, rinse thoroughly in cold running water followed by a drying dip in hot water.

(To be Concluded)

Electrochemical Removal of Broken Tools



One of the most annoying problems in metal working operations is the breaking of drills, taps and reamers in such a way that part of the tool remains lodged in the work. Because this situation often means scrapping of the part or the tedious removal of the tool by prying and gouging, the development of the quick, automatic, electrolytic method for broken-tool removal described in this article represents a real contribution to increased production. The method is of special value for removing broken tools from aluminum or magnesium parts. For other materials (and for other than steel tools, also) non-electrolytic chemical methods have been developed and are also described herein.

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by J. L. BLEIWEIS AND A. J. FUSCO

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THE PROBLEM OF SALVAGING and utilizing all materials, especially in time of war, is an important one for any industrial establishment. This problem is part and parcel of the whole question of production increase whether evaluated from the point of view of quantity of production or cost of production. Many castings in industry have had to be rejected because various industrial tools such as drills, reamers, taps, etc. have broken off in these castings in such a manner as to defy removal without seriously injuring the castings beyond the point of utility.

Aircraft and other industries have been beset by the problem of broken tools, particularly in aluminum castings. In order to cope with this serious problem we have developed an electrolytic process whereby broken steel tools can be removed from aluminum and its alloys. This process is applicable to the removal of taps, studs, drills, reamers, plug-gages, etc. from drilled or threaded holes of any size or shape without altering the dimensions of the holes or marring the surface of the aluminum part.

In the course of the development of this process, the removal of broken tools from many other metals by both chemical and electrolytic methods was also developed. The method for the removal of broken tools from aluminum and its alloys by electrolytic drilling will be discussed in detail followed by a discussion of the electrolytic and chemical methods as modified for magnesium, brass, bronze, Monel metal, stainless steel, etc.

The Principle Involved

This process is based on the principle that the solution of metals in various electrolytes is enhanced if the metal is made the anode in an electrolytic process. However, for this application, it is necessary that the broken tool be dissolved selectively without solution of any portion of the part to be salvaged. When applied to the combination of steel in aluminum, difficulty arises from the fact that aluminum is above iron in the electrochemical series and therefore more active. This complicates the problem because optimum removal of broken steel tools will be effected only if little or no aluminum will be removed. Fortunately, however, aluminum under certain conditions will build up upon itself a protective oxide coating, which, if it is non-porous and insoluble, will completely protect the aluminum from further attack.

Through exhaustive experimental work, it was found that the best solution for the removal of steel parts from aluminum castings was a saturated solution of ammonium sulphate (750 gms. per liter). Generally speaking it was found that sulphates as a class gave the most satisfactory results. By controlling temperatures and concentrations carefully, sulphuric acid can be made to yield good results, but in many cases tolerances will be lost, a situation which is entirely avoided by the use of ammonium sulphate.

In many instances parts may be immersed in a tank, as the anode in an electrical circuit with ammonium sulphate as the electrolyte, and by electrolysis, the broken steel tools may be removed simply and with no detrimental effect to the aluminum. This batch process is only applicable when the part to be sal-

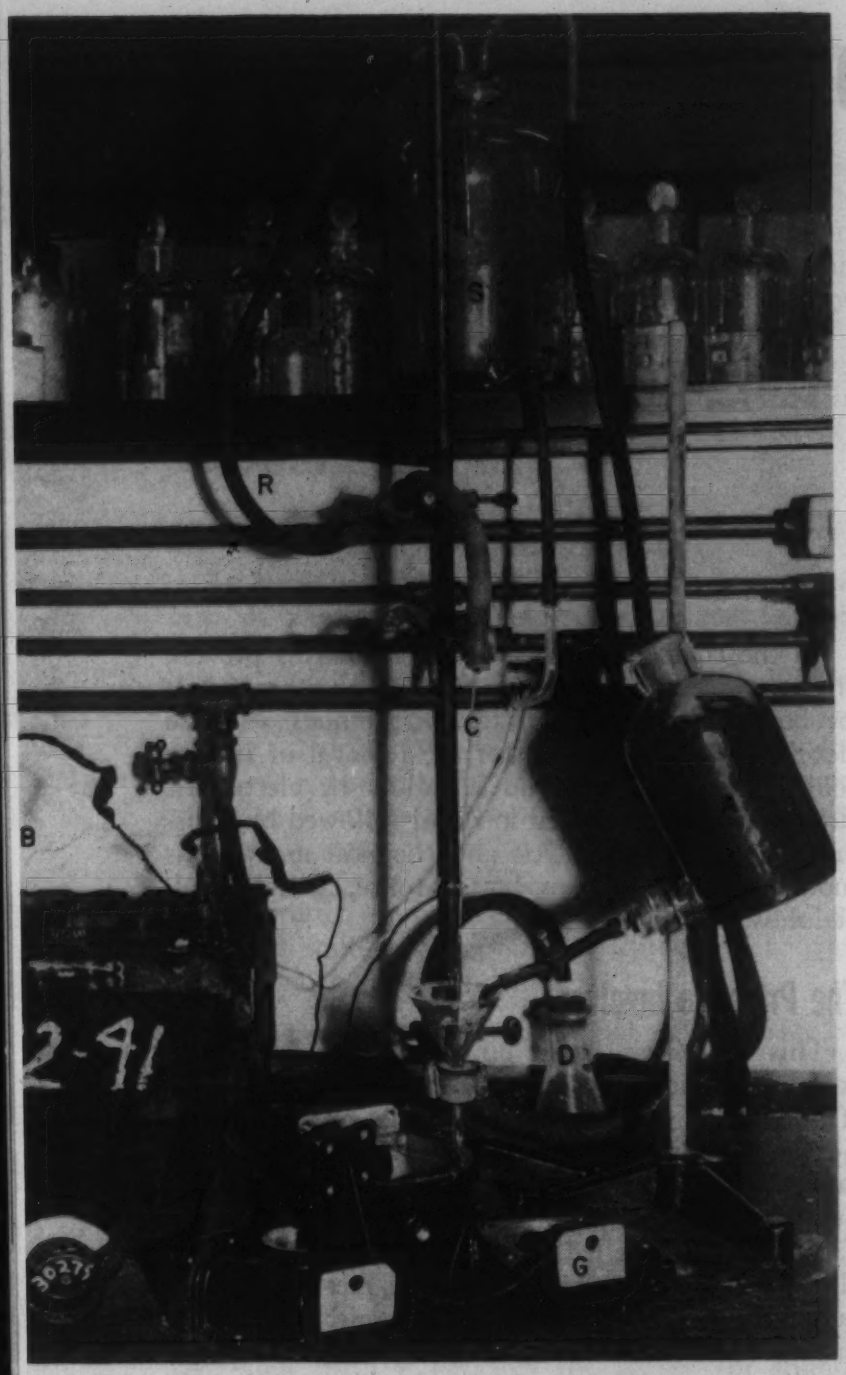


Fig. 1. Apparatus for electrochemical drilling. (Details are explained in the text.)

vaged contains no metallic inserts other than the part to be removed. Such inserts would be partially or completely removed along with the broken steel tool.

In order to avoid damaging any inserts, painted surfaces or specially finished parts and to do away with the cumbersome procedure of immersing very large aluminum parts into a tank for the removal of small steel tools, a special electrolytic apparatus was designed for the purpose of localizing the electrolytic action over the area of the broken tool to be removed.

The Apparatus Described

This apparatus developed on a laboratory scale and used for preliminary development work is illustrated in Fig. 1. In order to localize the area of reaction to the steel tool primarily, it is necessary to design a "Driller." This "Driller" (F) as can be seen from the illustration is simply a funnel or funnel shaped part constructed in this case of glass although many other materials may be used. The funnel is used primarily as a liquid intake and as a medium for localizing of the electrochemical reaction. Fitting down through the hollow stem of the funnel is a length of brass tubing (C) which acts both as a cathode for the electrolytic process and as a conduit for recirculation of the electrolyte.

The top of the brass tube is connected to a suction manifold, in this instance a length of rubber hose (R). Suction is obtained by means of an aspirator system or suction pump. The suction system is the medium by which recirculation of the electrolyte is obtained. The large bottle (S) on the table rack is used both as a means of retaining all of the electrolyte which is used over and over again, and also as an aspirator bottle in order to maintain a closed suction system. The small bottle (D) in the trough is merely a "safety" aspirator bottle used to prevent the entrance of water into the main body of the electrolyte. The bottle (A) near the funnel is the electrolyte feed bottle. The storage cells (B) are the sources of electrical power and the casting (G) in which the tool has been broken, is the anode. An ammeter is also used.

Operating the Laboratory Apparatus

The laboratory apparatus for localizing the electrochemical action is operated as follows: The center tube, C, is adjusted so that it is as close as possible to the broken steel piece without, however, touching either the steel or the aluminum. Short circuiting would result if the center tube C, which is the cathode, touched any part of the casting which is the anode. The electrolyte is then allowed to flow into the funnel from the feed bottle A at that rate which gives maximum current but no leakage. Recirculation is in the meantime being effected and leakage prevented by the suction built up by the aspirator system.

The voltage used in our laboratory is 24 volts, but this is by no means optimum voltage. Voltage regulation may be obtained if a rectifier is used and the highest voltage which will not affect the aluminum should be used.

As the electrochemical drilling proceeds the current will begin to drop. This occurs because as the steel piece is dissolved, the distance between it (anode) and the center tube (cathode) increases. When the current drops to about 25% of its initial value, the center tube should be moved down into the hole and, as before, as close to the steel piece as possible without causing short-circuiting. Automatic devices which allow the center tube to move down as the steel piece dissolves are desirable and should be used to insure greater automaticity of the process.

When the ammeter registers zero, the removal of the steel tool is complete. In actual practice, toward the completion of the electrochemical drilling, the ammeter begins to register less and less current and suddenly drops to zero indicating completion.

The Commercial Set-Up

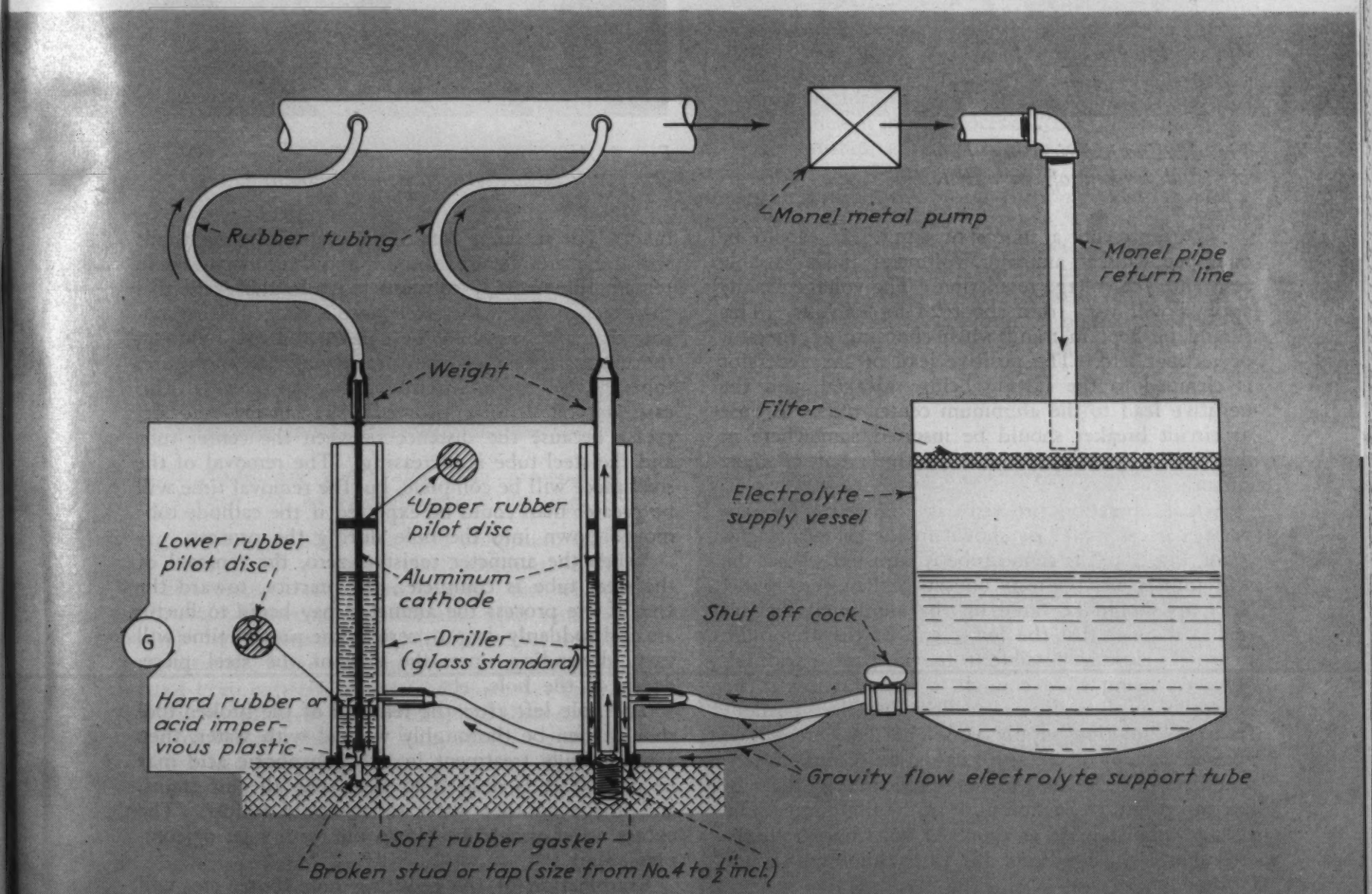
In the set-up to be used on a commercial scale many modifications of the laboratory apparatus have been made as the following description will reveal:

The "Driller," as can be seen from Fig. 2, is simply a cylindrically shaped part constructed, in this case, of hard rubber. It is used primarily as a liquid intake and as a medium for localizing of the electrolytic reaction. Fitting down through the hollow stem of the "Driller" is a length of hollow aluminum or Monel tubing (many other materials may be used) which acts both as a cathode for the electrolytic process and as a conduit for recirculation of the electrolyte. This tube is a very important part of the apparatus as will be pointed out in detail later when the operation of the apparatus is described.

The top of the aluminum tube is connected to the suction manifold by means of a length of rubber hose. Suction is obtained by means of a Monel metal suction pump which assures automatic recirculation of the electrolyte. The solution supply tank is merely a reservoir for the electrolytic solution. It is equipped with a filter the function of which is to remove iron hydroxide from the solution so as to prevent subsequent clogging of the cathode tube. The shut off cock regulates the flow of solution. The "Driller" is equipped with two rubber pilot discs which guide the aluminum cathode tube and a soft rubber gasket which prevents leakage of the solution.

The aluminum cathode tube is fitted with a small hard rubber or acid impervious tip. This tip which has cut-outs at its lowest end to allow free solution flow, prevents the cathode tube from contacting the casting at any time. If the casting and center tube contacted each other, short circuiting would result. A weight rests upon the upper end of the aluminum tube to provide a force which will cause the hard rubber or plastic tip to bear against the surface of the broken tool. This feature of the apparatus insures a constant distance between the bottom of the aluminum cathode and the broken tool throughout the entire process of removal.

Fig. 2. Schematic arrangement of electrochemical drilling apparatus.



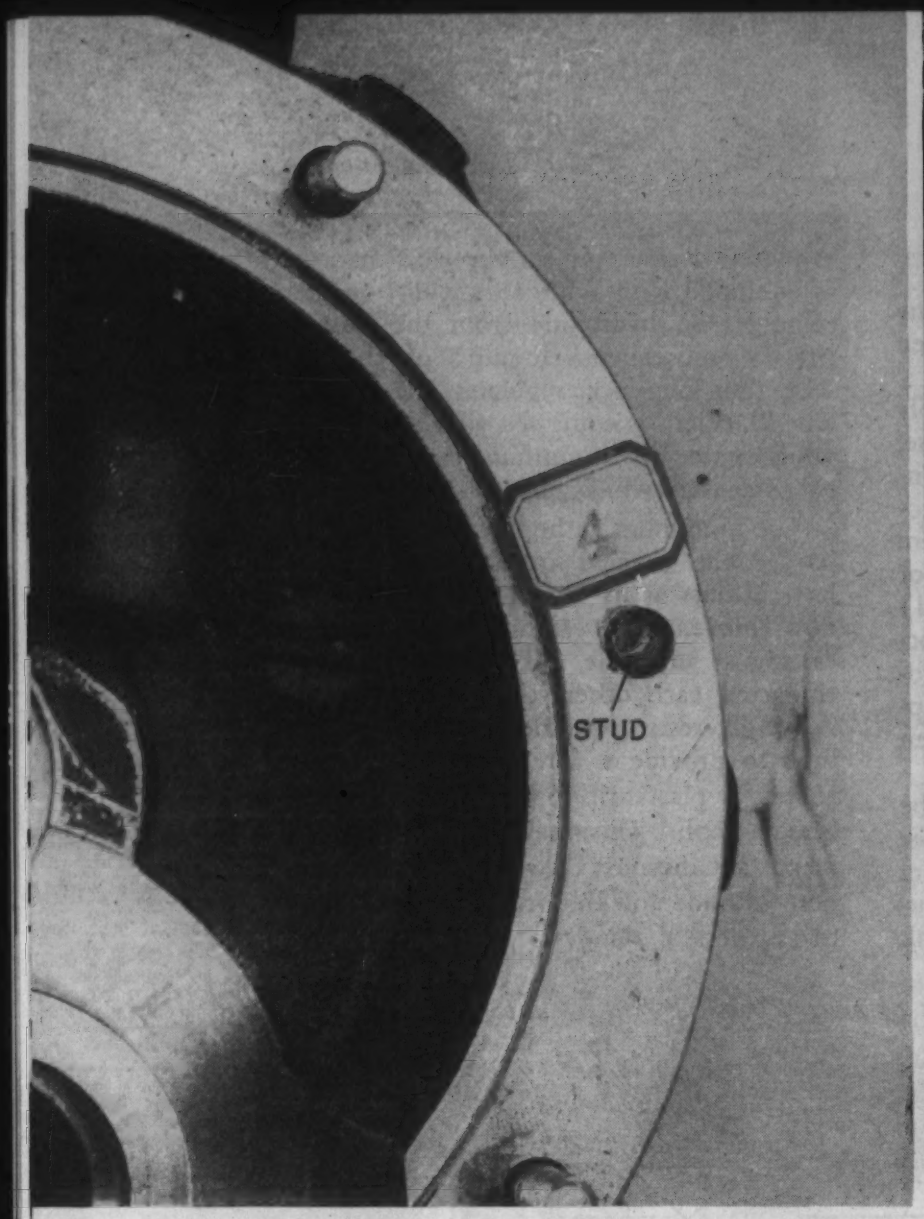


Fig. 3. Aluminum casting showing stud broken off in a hole.

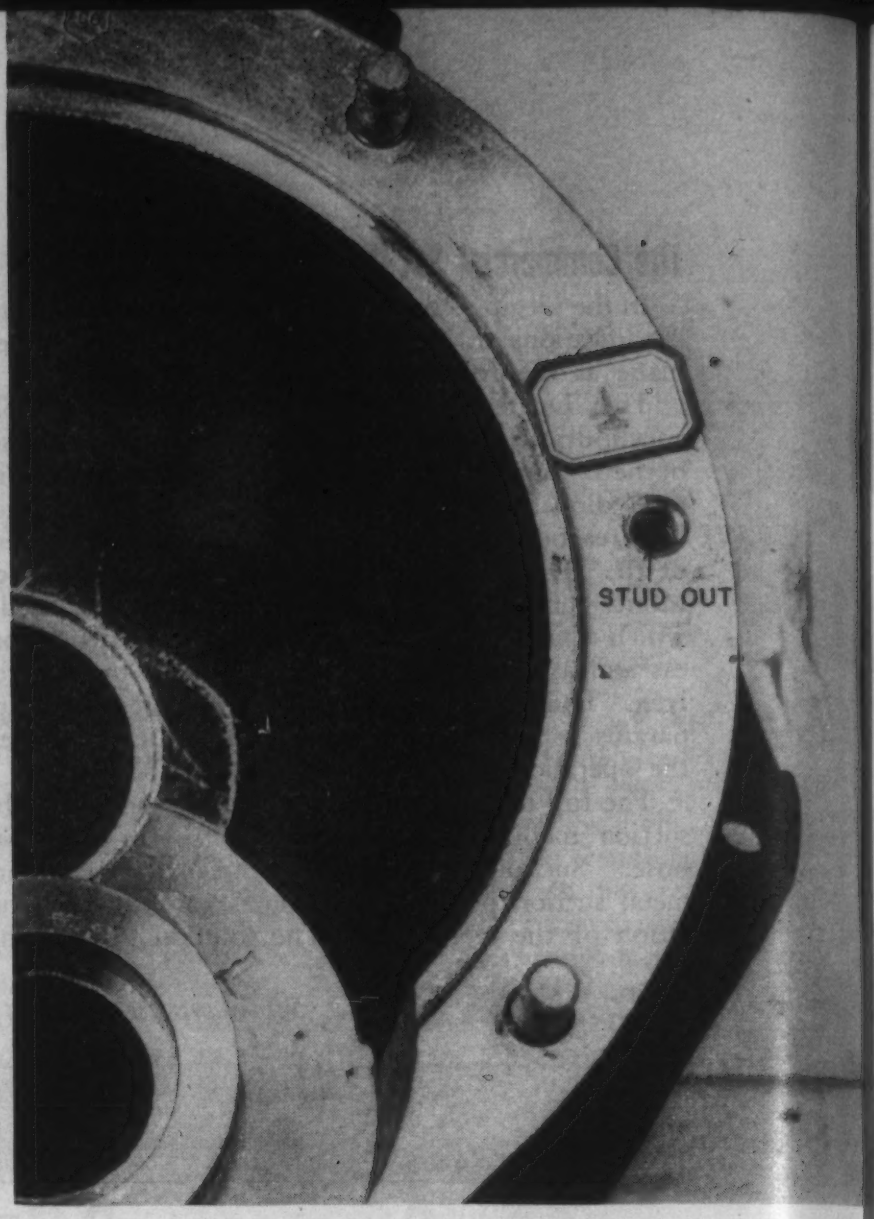


Fig. 4. Aluminum casting after the removal of a stud by electrochemical drilling.

"G" represents a source of e.m.f. It should be equipped with an ammeter, voltmeter and a variable resistance for voltage regulation. The voltage usually applied will vary from about 24 to 50 volts. This should be kept in mind when choosing a generator or rectifier, etc. The positive lead of the generator is clamped to the casting being salvaged, and the negative lead to the aluminum center tube. A fuse or circuit breaker should be inserted somewhere in the line as a safety measure in the event of short circuiting.

Actual operation proceeds as follows: The apparatus is assembled as shown in the schematic diagram, Fig. 2. The center tube is adjusted so that the acid impervious tip rests on the broken steel piece. This tip should be fitted on the aluminum tube in such a manner that the lower end of the aluminum tube is as close as possible to the steel piece without, however, being close enough to cause arcing. The electrolyte is then allowed to flow into the "Driller" from the solution supply vessel at that rate which gives maximum current. Recirculation is in the meantime being effected and leakage prevented by the rubber gasket and by suction built up by the pump. The voltage usually is set at about 24 volts but the highest voltage which will not affect the aluminum should be used.

As the electrolytic tool removal proceeds, the cathode tube moves down into the hole, forced down by the weight which rests on the upper end of the tube. The distance between the anode and cathode will therefore remain constant, and the current should remain substantially constant too. In the event that the hole, in which the steel piece is lodged, is so narrow that a tube cannot be constructed to fit into it, the entire process can be carried on with the center tube above the plane of the casting surface. In this case, as the drilling proceeds, the current will decrease because the distance between the center tube and the steel tube is increasing. The removal of the steel piece will be complete, but the removal time will be greater than could be expected if the cathode tube moved down into the hole during the process.

When the ammeter registers zero, the removal of the steel tube is complete. In practice, toward the end of the process the ammeter may begin to fluctuate and suddenly drop to zero. The process time will vary, depending upon the size of the steel piece, depth of the hole, etc.

The hole left after the removal of the broken tool should then be thoroughly washed with water, then a one minute treatment in 1:1 phosphoric acid may be used if it is desired to clean out all rust stains, and finally another water rinse should follow. The excess water should be blown out with a jet of compressed air.

Examination of the resulting hole, bore, etc. will show complete absence of any corrosive effect on the aluminum. Walls will be left smooth, threads will be intact and shiny. All holes will conform to toler-

ance specifications when gaged.

The only evident damage to the aluminum will be that caused by mechanical marring of the metal when the steel tool breaks or that caused by any attempt to mechanically remove the broken tool by prying, gouging, hammering, etc. The mechanical damage usually occurs near the top of the hole and may evidence itself in the form of marred countersinkings or burred threads, etc.

Some Actual Results on Aluminum

As examples of the work which has been and can be effected anytime, photographs and X-ographs are submitted. In practice broken tools as small as 3/64 in. in diameter have been removed and this is by no means the lower limit. Fig. 2 illustrates the apparatus used for localizing the electrolytic reaction to the area of the broken tool. Fig. 3 shows an aluminum casting with a stud broken off in one of the holes. Fig. 4 shows the same casting as shown in Fig. 3 after removal of the stud by electrochemical drilling. The hole was in perfect condition and was within tolerance limits. Fig. 5 shows an aluminum gyroframe after removal of a tap from a 2/64 hole by electrochemical drilling. The threads were intact and shiny and the hole was within tolerance limits.

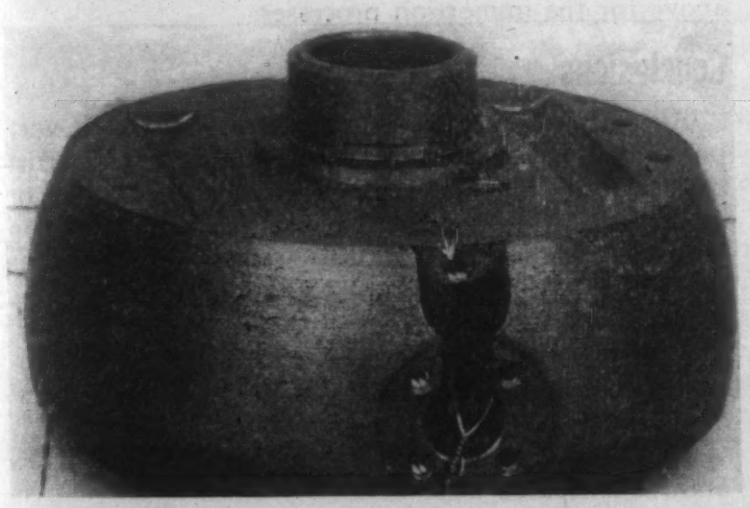


Fig. 5. Aluminum gyro-frame after removal of a broken tap by electrochemical drilling.

Fig. 6 shows a black anodized aluminum housing after removal of a tap by electrochemical drilling. The first three threads were "belled" out when the tap broke. The remaining threads, after removal of the tap by electrochemical drilling, met tolerance specifications. Note that the electrochemical drilling did not even entirely remove the black dye from the surface, an indication of the complete absence of corrosion of the aluminum by this process.

Fig. 7 is a pair of X-ographs showing first a stud broken off in an aluminum casting and, second, the same casting showing the stud partially removed by electrochemical drilling. Fig. 8 is a pair of X-ographs of an aluminum casting before and after removal of a tap by electrochemical drilling.

Fig. 6. Aluminum housing showing tap removed by electrochemical drilling.

As Applied to Other Materials

The electrolytic removal of broken tools from magnesium is accomplished with the same apparatus as that described for aluminum with modifications of materials only. The electrolyte is mainly 48 to 52 per cent hydrofluoric acid with additions of inhibitors such as isopropyl alcohol, other alcohols or organic compounds which will retard corrosion of the magnesium and not inhibit solution of the broken tool.

The straight chemical or immersion process of removing broken tools from various metals has the advantage of being able to handle large quantities of parts at one time, requires no equipment other than an immersion tank and possibly a temperature controlling device, and features simplicity of operation with very little supervision or maintenance. The procedure to be followed is simply as follows:

1. Remove all grease and dirt from the broken tool to be removed.
2. Immerse the part or portion of the part from which the tap is to be removed in the proper solution.
3. Examine parts from time to time to see if the broken tool has been removed.
4. When the broken tool is completely removed, rinse the part thoroughly in cold running water until all acid has been removed.
5. Dry with a blast of compressed air.

This immersion method has certain disadvantages which are inherent in the process such as deteriorating of certain finishes, effecting slight surface etching in some cases, and being inapplicable in cases where immersion will remove metal portions which should not be removed.

A list of immersion solution processes for salvaging industrial parts in which tools or other undesirable metal bodies are lodged by removal of these metal bodies follows with an explanation of the operation of each process:

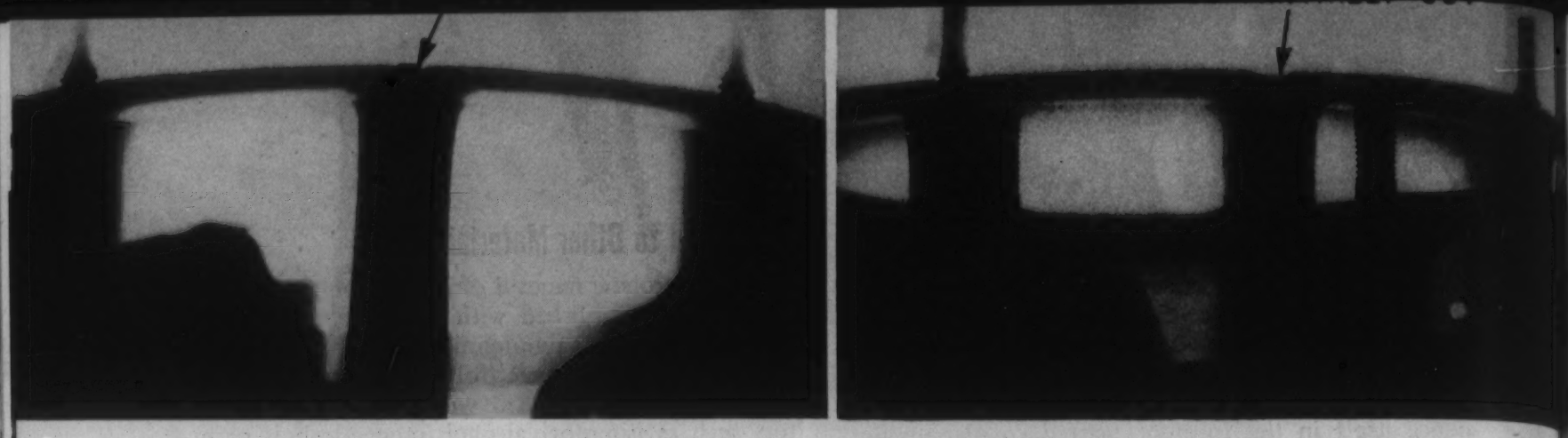


Fig. 7. Aluminum casting (left) showing a stud broken off in a hole. Aluminum casting (right) showing stud partially removed by electrochemical drilling.

1. Removal of brass or bronze inserts or studs from aluminum: The castings are to be immersed in a solution of nitric acid which will remove the brass or bronze portion without damaging the aluminum. The optimum conditions are concentrated nitric acid as the solution agent maintained at temperatures from 0 to 20 deg. C. (32 to 68 deg. F.) This will insure a minimum etching of aluminum although various other dilutions of nitric acid and greater temperature ranges may be used.

2. Removal of Steel Bodies from Aluminum: The reagent in which the aluminum parts are to be immersed is dilute nitric acid. The dilutions may vary depending upon the steel part encountered and the temperature may vary within large ranges. Optimum temperatures, however, from the point of view of minimum attack on the aluminum will be 0 to 20 deg. C. (32 to 68 deg. F.) The process, as mentioned above, will dull or etch the aluminum surface slightly and remove alumilite dye, paints, or other surface finishes but the process may be applied to rough castings or small parts.

3. Removal of steel tools and studs from copper or copper base alloys: The reagent used is a water solution of stannous chloride and hydrochloric acid at elevated temperatures. Sulphuric acid may be substituted in certain cases and other chlorides or sulphates may be substituted for stannous chloride. Concentrations of these reagents may vary over a wide range as may temperature although the boiling point of the solution is a very satisfactory temperature.

Hydrochloric acid, by itself, will attack brass and bronze somewhat, apparently causing dezincification. The addition of stannous chloride inhibits this action to the point where attack on the brass or bronze is imperceptible.

4. Removal of steel tools or studs, brass or bronze inserts or studs from Monel metal: Immerse the parts in dilute hydrochloric acid at almost any temperature.

5. Removal of steel tools or studs, brass or bronze inserts or studs from stainless or corrosion-resistant steel: Immerse the parts in a solution of nitric acid. The concentrations of the acid may vary from very dilute to concentrated depending upon the material to be removed. The temperatures should be elevated for optimum removal.

The apparatus as described in Fig. 1 may also be used for straight chemical solution of the broken tool whenever it is desirable to localize the action of the solvent at any one point. When the apparatus is used for this purpose it is quite obvious that no electrical connections or source of voltage is required. The electrolyte to be used will be the same as outlined above for the immersion processes.

Conclusions

Although the removal of broken tools from every possible alloy has not been investigated, it is felt that broken tools may be removed either chemically or electrolytically from most if not quite all the alloys in which the composition of the embedded material is substantially different from the composition of the surrounding metal.

Removal of broken tools by chemical and electrolytic methods has certain advantages over mechanical methods:

1. Threaded parts may be removed as easily as unthreaded parts.
2. Hardened steel tools are removed as easily as softer studs, etc.
3. Tightly wedged broken tools present no difficulty.
4. No surface marring due to mechanical gouging occurs at any time.
5. Simplicity and automaticity of operation requiring the use of only inexperienced labor materially aids in lowering the costs of salvaging.

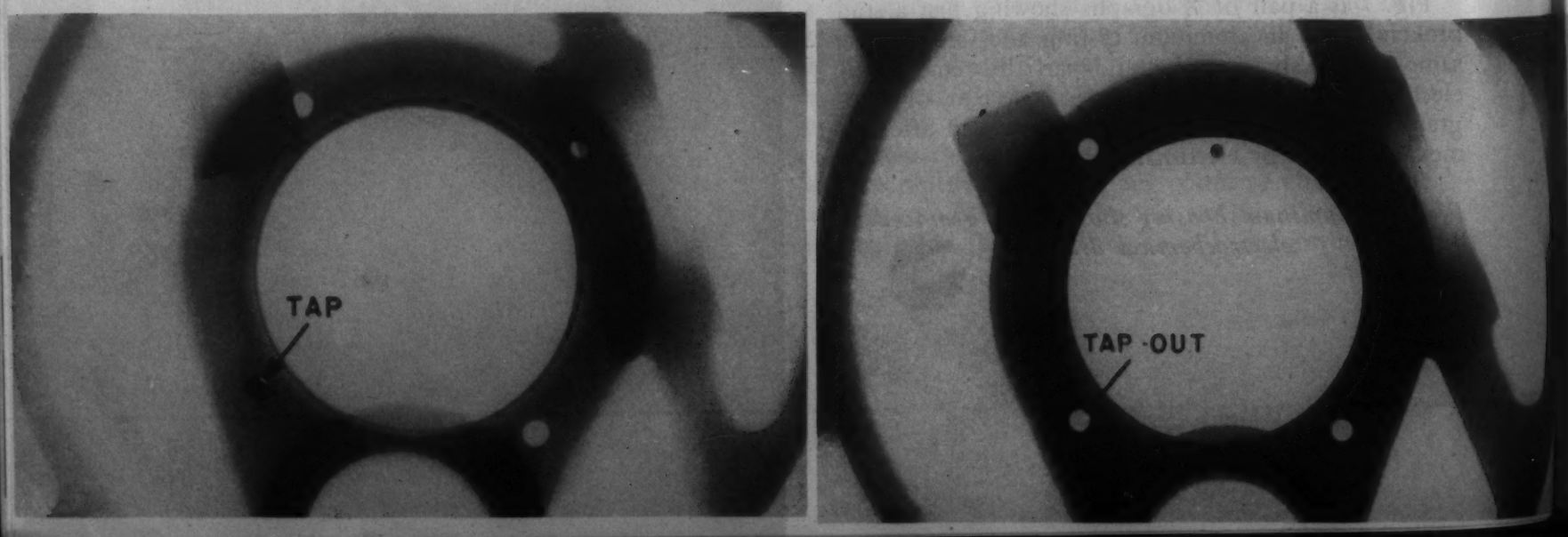


Fig. 8. Aluminum housing (left) showing tap broken off in a hole. Aluminum housing (right) showing the hole after the removal of the tap by electrochemical drilling.

High-Manganese Stainless Steels

A Correlated Abstract-Part 2

This, the second and concluding instalment of Professor Mack's review of stainless steels in which all or part of the nickel is replaced by manganese, covers the scaling resistance and corrosion resistance of these steels. The other installment was published in September. —*The Editors*

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After annealing and pickling, stainless steel strip is recoiled preparatory to further processing or to shipment. In order to protect its surface, the strip is carefully interleaved with specially prepared paper. (Courtesy: United States Steel Corp.)

Resistance to Scaling

Chromium is the basic element in imparting oxidation resistance at high temperature to steel (aluminum and silicon are also very effective but cannot be used in large amounts because of their bad effects on working properties). It is to be expected that the addition of nickel would decrease scaling resistance, and Table VI shows this to be true.

Despite the fact that the austenitic alloys do not have as good scaling resistance as the ferritic alloys, they are used extensively at high temperature because of their good load-carrying ability and fairly good scaling-resistance properties. With additions of aluminum, silicon, molybdenum, or tungsten, they compare favorably with the ferritic alloys.

The oxidation resistance of the manganese 18 and 8 alloys has been reported in almost all papers on these steels. Brühl,[7] Monypenny,[36] Kinzel,[22] Krivobok,[25] Legat,[28] and Brown[6] state that, when judged by gain in weight, the chromium-manganese 18 and 8 steels oxidize more readily than standard 18 and 8 at high temperatures. Kluke[23] found that even small amounts of manganese rapidly lowered the good scaling resistance of the 30 per cent Cr irons; manganese behaved worse in this respect than nickel.

However, Schmidt and Lamarche[42] claim that, in general, the oxidation-resisting chromium-nickel steels can be replaced for temperatures up to 950 deg. C. (1750 deg. F.) by chromium-manganese, chromium-manganese-nitrogen, or chromium-manganese-silicon steels. They recommend a composition of greater than 15 per cent Mn, less than 15 per cent Cr, plus addition of titanium, tantalum, columbium, or nitrogen. This composition is not consistent with the known effect of chromium content on oxidation.

Substitution of some silicon for some of the chromium in the chromium-manganese steels will give an alloy that can be safely used up to 1200 deg. C. (2200 deg. F.).[28] Where high-temperature uses of the chromium-manganese steels are cited,[6] their use is claimed to be on the basis of high-temperature strength plus fair resistance to scaling, a maximum recommended operating temperature being 815 deg. C. (1500 deg. F.).[25] The chromium-manganese alloys to which nickel has been added have scaling properties more comparable to the standard 18 and 8 steels.[15]

Investigators[3, 17, 22, 28, 35, 36, 42] agree that the chromium-manganese 18 and 8 alloys are much more resistant than standard 18 and 8 steel to attack by sulphurous or sulphur-bearing gases at all temperatures. This is quite logical since nickel, even in

TABLE VI. Scaling Tests at Elevated Temperatures on Some Stainless Alloys[34]

Condition of tests	Gain in weight, mg. per sq. cm.			
	17% Cr, Type 430	27% Cr, Type 446	18% Cr-8% Ni, Type 304	25% Cr-12% Ni, Type 309
50 hr. at 2010° F. in air	7.0	2.5	15.0	9.0

TABLE VII. Compositions[11] *and Probable Structures of Some Chromium-Manganese Stainless Steels*

No.	Composition, per cent					Probable structure[a] after quench from high temperature
	Cr	Mn	Ni	Cu	C	
A	14.8	10.0	2.1	—	0.15	Austenitic
B	16.1	10.1	2.1	—	0.12	Austenitic
C	18.3	9.0	—	0.8	0.08	60% austenite-40% ferrite
D	14.1	8.8	1.5	0.3	0.10	85% austenite-15% ferrite
E	15.2	11.8	2.1	0.5	0.12	Austenitic

[a] *Deduced from the chromium, manganese, and nickel contents and the work of Burgess and Forgeng.*[8]

small amounts in alloys, is notorious for reducing resistance to sulphur and its compounds.

Corrosion Resistance

The most extensive use of the stainless steels is for combatting corrosion by a great variety of chemicals at ordinary temperatures. Hence, the susceptibility of the chromium-manganese 18 and 8 alloys to such corrosive agents must be investigated before it can be substituted for the standard 18 and 8 steels. One of the important related problems is the tendency toward carbide precipitation with resultant intergranular corrosion in the chromium-manganese 18 and 8 alloys. It must be kept in mind that this difficulty arises in standard 18 and 8 because of the metastability of its austenitic structure.

Since the chromium-manganese 18 and 8 never can be put into a completely austenitic structure, but always consists of a mixture of austenite and ferrite, it follows that the presence of some ferrite should cause release of some of the carbides held in supersaturated solid solution in the metastable austenite, thus reducing the tendency toward carbide precipitation and resultant intergranular damage during corrosion. (This can be illustrated by comparison of the relative damage done to Type 304 (austenitic) and Type 316 (austenitic-ferritic) by intergranular corrosion. The damage is usually more severe to Type 304.)

In addition, since the manganese is a carbide former (nickel is not a carbide former) it should tie up some of the carbon. This would leave less carbon available to form chromium carbide, which, if precipitated at the grain boundries, will deplete the adjacent matrix of chromium and allow intergranular corrosion. Kinzel[22] reporting on corrosion tests on welds in chromium-manganese stainless steel says, " . . . while the material is rendered susceptible to attack by acidulated copper sulphate solution, the degree of susceptibility is rather low. Less corrosive materials like atmosphere, salt water, and nitric acid do not attack grain boundaries rapidly enough to render the material unserviceable from an engineering standpoint."

Mitchell[35] and Krivobok,[25] without stating the degree of susceptibility, warn that these chromium-manganese stainless steels are subject to intergranular corrosion if sensitized at the correct temperature. Parks[38] has shown that, in furnace-cooling an alloy containing 12 Cr and 20 per cent Mn, the ferrite is rejected in a Widmanstätten pattern with no precipitation at the austenite grain boundaries. He interprets this as evidence that the precipitation process is a sluggish one and, hence, predicts freedom of these alloys from intergranular attack; this is borne out by his corrosion tests.

In another paper Kinzel[29] states that the carbides in chromium-manganese 18 and 8 cannot be stabilized by the addition of carbide-forming elements (presumably columbium, titanium, or tantalum). Legat[28] disagrees with Kinzel because he finds that intergranular corrosion still occurs in the chromium-manganese 18 and 8 even when the carbon is very low or when it is (presumbaly) tied up by titanium, tantalum, or columbium. He believes that this intergranular attack is caused, not by carbide precipitation, but by solution of some manganese-rich phase that collects at the grain boundaries. Evidence of the existence of this manganese-rich phase has been presented by de Sy,[11] Brühl,[7] and Parks.[38]

When nickel is added to the chromium-manganese 18 and 8 steel in an effort to improve some of the other properties, the steel becomes much more liable to intergranular attack because of carbide precipitation due to the powerful effect of the nickel in retaining metastable austenite from which the carbides can be rapidly precipitated. Increasing the manganese content or reducing the chromium content can have the same effect.[20] This is also shown by the data of de Sy,[11] who determined the susceptibility of five steels (see Table VII for compositions) to intergranular attack by means of the Strauss test. He found that after annealing at 725 deg. C. (1335 deg. F.) (in the range where carbide precipitation occurs most rapidly), Steels A, B, D, and E were very susceptible to intergranular attack while Steel C showed only general attack.

Steel C exhibited some intergranular corrosion when sensitized 1 hr. at 600 to 650 deg. C., (1110

to 1200 deg. F.), but the attack was not serious. With still larger amounts of nickel or manganese (or both) and lower amounts of chromium, the alloys develop the same sensitivity to intergranular attack shown by standard 18 and 8.[14, 20]. Armstrong metal[15] seems to be an exception, probably because it is stably austenitic at room temperature although its composition (17½ Cr, 4 to 6 Mn, 8 Ni, 2.9 per cent Cu) does not seem to be such as to give stable austenite.

Some interesting data are presented by Franks.[13] He shows that the addition of 2.05 to 4.53 per cent Mn to standard columbium stabilized 18 and 8 results in better corrosion resistance (to boiling 65 per cent nitric acid) after welding than is obtained in the same steel with low manganese (0.60 per cent). The reason for this is not clear.

Since it can be concluded that chromium-manganese 18 and 8 steel is probably not so susceptible to intergranular attack as standard 18 and 8 steel, its corrosion resistance to chemical agents as reported in the literature may be reviewed. For all-round corrosion resistance, the addition of ½ to 3 per cent Cu to the chromium-manganese 18 and 8 is recommended. [3, 4, 5, 15, 17, 21, 22] The copper tends to promote formation of protective surface films when the alloy is subjected to corrosive conditions of low oxidizing power.[22]

The higher manganese steels also are less resistant than the high nickel steels when subjected to strongly reducing corroding media.[42] Addition of copper also increases resistance under these conditions.[5] Addition of nickel or substitution of some nickel for some of the manganese apparently improves the all-round corrosion resistance. [5, 15, 20, 21, 22, 26, 28] Since the basic purpose of adding manganese to stainless steels of the 18 and 8 type is to replace the scarce nickel, certainly no more nickel should be used in the steel than is considered necessary.

Tables VIII and IX give some of the published results on the corrosion resistance of the chromium-manganese 18 and 8 steel to various corrosive media. Comparative results on standard 18 and 8 steel are given also. Grimshaw[15] says, " . . . increase in manganese content up to 12 per cent increases the resistance to sulphuric acid and sulphurous media, but decreases the resistance to most other chemicals. Manganese alone, added to standard 18 and 8 steel, decreases its resistance to corrosion (in cold 10 per cent H_2SO_4) unless accompanied by copper. If resistance to nitric acid is of prime importance, manganese lower than 4 per cent (with 4 to 8 per cent Ni) is necessary."

Parks[38] finds almost the reverse to be true. It has also been shown[1] that the chromium-free high-manganese steels will rust in the atmosphere, with or without additions of nickel and copper. Addition of 3 per cent Cr greatly retards progressive rusting while 12 per cent Cr gives a high degree of resistance to rusting. These same effects have been previously reported by Fuchs.[14]

TABLE VIII. Corrosion Resistance of Some Low-Carbon Stainless Steels to Various Media[19]

Corrosive Medium	Conc'n., per cent	Temperature, deg. C.	Alloys		
			18 Cr-8 Mn-1 Cu	18 Cr-8 Ni	18 Cr-8 Ni 2.5 Mo-1.5 Cu
Orthophosphoric acid	10	20	Yes[a]	Yes[a]	Yes[a]
Formic acid	10	20	Yes	Yes	Yes
Formic acid	30	20	Yes	Yes	Yes
Citric acid	10	20	Yes	Yes	Yes
Acetic acid	10-50	20	Yes	Yes	Yes
Acetic acid	Glacial	20	Yes	Yes	Yes
Tannic acid	10	100	Yes	Yes	Yes
Phenol	10	100	Yes	Yes	Yes
Sodium carbonate	10	100	Yes	Yes	Yes
Lead acetate	25	100	Yes	Yes	Yes
Potassium nitrate	50	100	Yes	Yes	Yes
Chromium sulphate	Sat.	100	Yes	Yes	Yes
Zinc chloride	1.2 sp. gr.	20	Yes	Yes	Yes
Nitric acid	10	20	Yes	Yes	Yes
Nitric acid	30	20	Yes	Yes	Yes
Nitric acid	10	100	Yes	Yes	Yes
Nitric acid	Conc.	20	Yes	Yes	Yes
Atmosphere	General	—	Yes	Yes	Yes
Atmosphere	—	Under 900	No[b]	No[b]	No[b]
Atmosphere	—	Above 900	No	No	No
Furnace gases	—	Under 900	Yes	No	No
Mine waters	—	20	No	No	No
Sulphur compound gases	—	Under 900	Yes	No	No
Flue gases	—	—	Yes	Yes	Yes
Mineral waters	(S)[c]	20	Yes	No	No
Lactic acid	1.5	100	Yes	Yes	Yes
Oxalic acid	10	20	Yes	Yes	Yes
Salt spray	—	20	No	No	No
Furnace gases (reducing)	—	950	No	No	Yes
Sulphite liquors	—	—	No	No	Yes
Sea water	—	—	No	No	Yes
Iron chloride (ferric)	Low	20	No	No	Yes
Ammonium nitrate	Sat.	100	Yes	Yes	Yes

[a] *"Yes" means that the alloy will satisfactorily withstand the chemical agent used in the test.*
[b] *"No" means that the alloy will not satisfactorily withstand the chemical agent used in the test.*
[c] *Mineral water containing sulphur compounds.*

TABLE IX. Corrosion Data on Chromium-Nickel, Chromium-Manganese, and Chromium-Manganese-Nickel Steels[a]

Composition	Cr-Ni steel quenched from 2100° F.	Cr-Mn-Ni steel quenched from 2100° F.	Cr-Mn steel quenched from 2100° F.
Chromium	17.90	17.76	17.73
Nickel	9.04	3.83	—
Manganese	0.40	6.09	8.63
Silicon	0.40	0.47	0.54
Carbon	0.10	0.07	0.08
Copper	—	0.95	0.86
Ferrite	0.0	20.0	40.0
Austenite	100.0	80.0	60.0

Corrosion Behavior

Reagent	Condition of tests	Loss in g. per sq. cm. per hr.[a]		
2% nitric acid	Boiling	0.0000006	0.0000006	0.0000008
10% nitric acid	Boiling	0.0000004	0.0000015	0.0000030
65% nitric acid[b]	Boiling	0.000025	0.000043	0.000106
10% sulphuric + 2% nitric acid	Room temp.	0.00006	0.0000056	0.0000011
10% acetic acid	Boiling	Nil	Nil	Nil
Glacial acetic acid	Boiling	0.000039	0.00040	0.00082
10% oxalic acid	Boiling	0.00025	0.00020	0.000145
10% orthophosphoric acid	Boiling	0.0000009	0.0000011	0.0000009
2% lactic acid	Boiling	Nil	Nil	Nil
Lemon juice	Room temp.	0.0000004	0.00000035	0.00000034
Orange juice	Room temp.	Nil	Nil	Nil
Canned tomatoes	212° F.	Nil	Nil	Nil
Canned rhubarb	212° F.	Nil	Nil	Nil
Sulphur dioxide	1020° F.	0.38[c]	0.13[c]	0.10[c]

[a] *Quoted from reference* [11]. *To convert loss in g. per sq. cm. per hr. to g. per sq. dec. per day, multiply by 2400. Data given are insufficient to convert to inches penetration per year.*

[b] *Standard Huey test.*

[c] *Per cent loss in weight.*

From Tables VIII and IX it is apparent that the chromium-manganese 18 and 8 is not as resistant as standard 18 and 8 to most corrosive media, the exception being for sulphurous environment. Other investigators[7, 11, 17, 22, 35] agree that its all-round corrosion resistance is inferior to standard 18 and 8 steel.

Conclusions

The major portion of published research on the substitution of manganese for nickel was carried out prior to 1939. Few authors described the raw materials used in making their alloys, and it is presumed that the manganese in these alloys was obtained from low-carbon ferromanganese produced by pyritic reduction of the ore. This was the only type of manganese generally available commercially before 1939. Since 1939, electrolytic manganese of high purity has become available commercially and has been used by some steel makers in the production of semi-commercial heats of manganese 18 and 8 steel and other similar alloys.

From what little information is available regarding these alloys made with electrolytic manganese, it appears that they have structures and properties that may be quite different from the alloys made with pyritic manganese. It is believed that the differences may be attributed to the presence of impurities in pyritic manganese and the absence of these impurities in electrolytic manganese. Hence, it is possible that chromium-manganese 18 and 8 steel made with electrolytic manganese would have different properties than those shown in Tables VIII and IX.

It is apparent that the manganese stainless steels have excellent working, welding, and fabricating properties. Although the evidence is not conclusive, the preponderance of opinion seems to be that the chromium-manganese stainless steels are less susceptible to intergranular corrosion caused by carbide precipitation than are the standard stainless steels. This is particularly true of welds. Despite this fact, their corrosion and oxidation resistance is generally inferior to the standard stainless steels; consequently, they cannot compete for applications where conditions are severe.

Since the manganese or manganese-nickel stainless steels will probably be cheaper than comparable standard grades, it is reasonable to expect that they may find use where corrosive conditions are not severe (as in exposure to the atmosphere, natural waters, and neutral salt solutions) or where operating temperatures and loads are not high enough to cause excessive oxidation or creep. Probably the best field of usefulness for these alloys will be in light-weight welded construction of aircraft, busses, and trains. In these applications full advantage can be taken of their lower cost and their mechanical properties, which are about the same as those of the standard grades of stainless steel.

Acknowledgment

The writer wishes to acknowledge the invaluable assistance given him in the preparation of this paper by Julius Silverberg and L. D. Yates, both of the Chemical Engineering Research and Development Division of the Tennessee Valley Authority.

New Method of Copper Brazing

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This brief article, a "war-production pointer," describes a new, simple set up for copper-brazing based on the use of a charcoal atmosphere. It can be employed either in an emergency breakdown of regular atmosphere equipment or to supplement such equipment in everyday production. —*The Editors*

THERE HAS BEEN IN USE for some time a conventional method of copper brazing for assembling small airplane parts made of S.A.E. steels. The parts are shown in Fig. 1.

This usual method of copper brazing as carried out is shown in Figs. 2 and 3. A copper pellet is

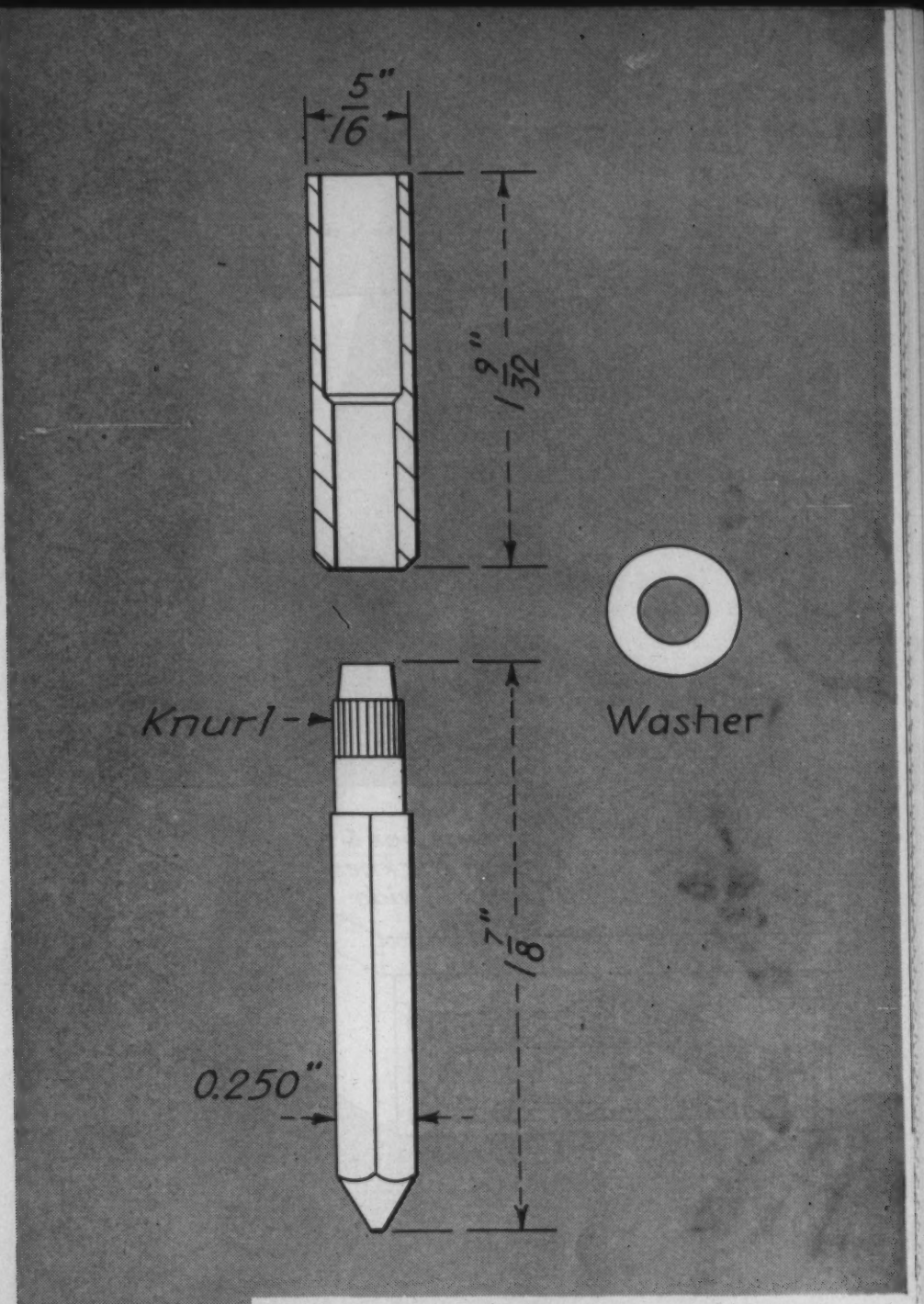
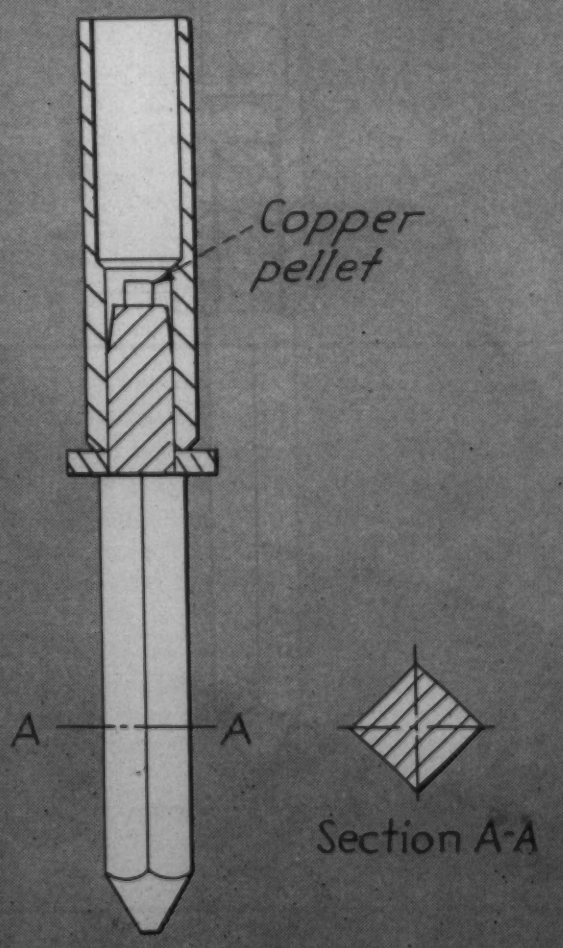
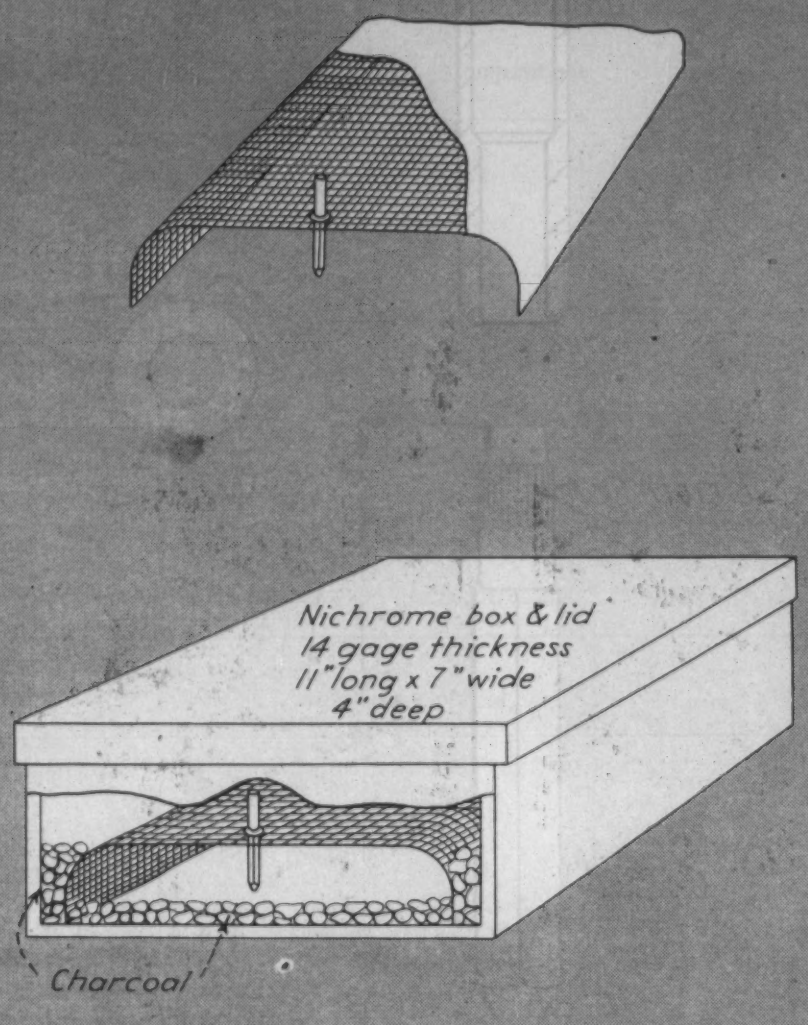
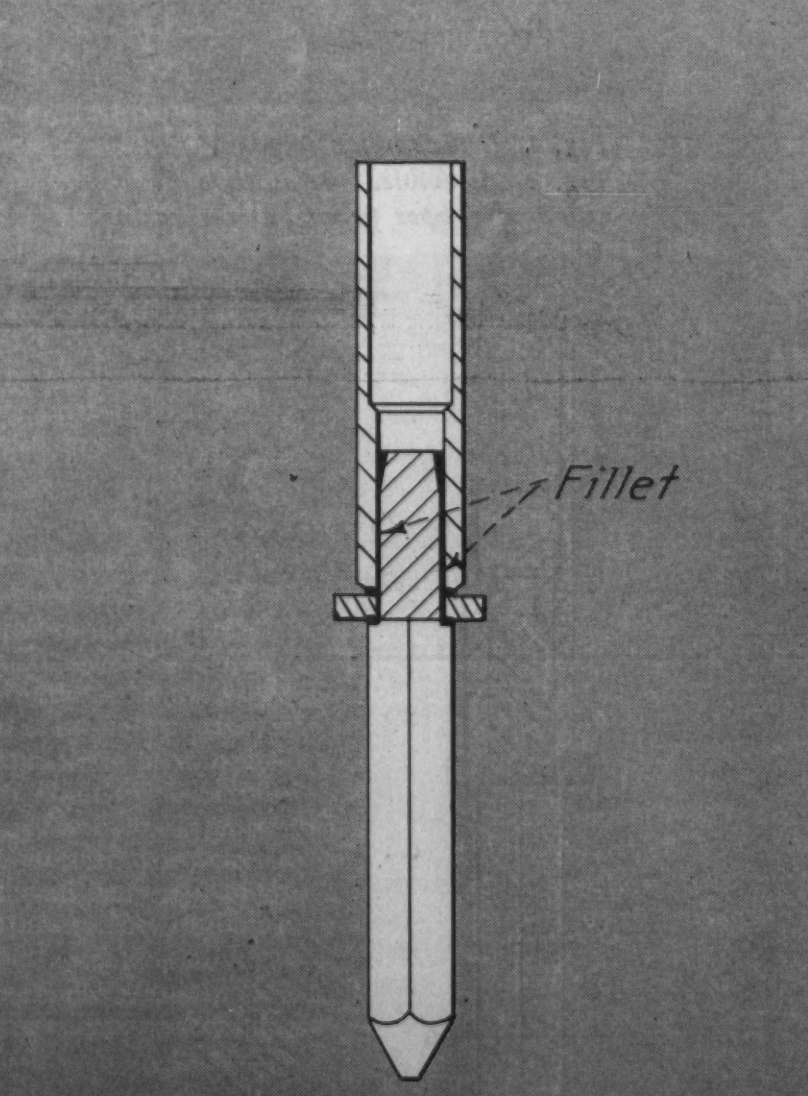


Fig. 1. Unassembled airplane parts.
Fig. 2. Assembled pieces showing position of copper pellet before brazing.







placed near the joint to be brazed. The pieces to be brazed are placed in an upright position and supported on a nickel-chromium alloy screen, Fig. 3. The screen, with the pieces, is then charged into a furnace operating at 2050 deg. F. A rich hydrogen and carbon monoxide atmosphere from propane gas, converted in a gas generator, is introduced into the furnace. It has been and is possible to satisfactorily braze several thousand pieces by this procedure.

If a breakdown of this atmosphere equipment occurs, a serious situation develops—it is imperative that daily production of these parts, so vitally needed in the war effort, be maintained. Such breakdowns have happened in our experience when no other brazing furnace, such as the one described, was immediately available. Other methods of brazing were tried, and ultimately a simple and effective method was found. It is described in the following paragraphs.

The New Method

With the same set-up of pieces as shown in Fig. 3, the screen is inserted in a nickel-chromium box containing a layer of wood charcoal, 3/4 in. thick on the bottom, Fig. 4. Charcoal is also placed on the sides of the screen. A lid is placed in the box and the contents heated in a furnace at 2050 deg. F. for 30 min.

After heating, the box is removed from the furnace and allowed to cool in air without disturbing the lid. The brazed pieces reveal a strong, clean airtight joint, Fig. 5. There is only a slight film of oxide on the surface of the pieces, and this film is easily removed by pickling. The presence of a reducing protective atmosphere, under the conditions described, produces a brazed joint which is as satisfactory as that obtained by the conventional method.

This novel method of copper brazing made possible the continued production of these parts without seriously disrupting the production schedule. It is believed that this method of brazing can be carried out in any furnace which can operate at 2050 deg. F. without introducing a reducing atmosphere into the furnace.

Fig. 3 (Top) Showing position of piece on nickel-chromium alloy screen.

Fig. 4. (Center) Position of pieces in box with charcoal, nickel-chromium box and lid, 14 gage thickness, 11 in. long, 7 in. wide and 4 in. deep.

Fig. 5. (Bottom) Finished piece after brazing with charcoal.

A few typical NE steel shaft components neutral hardened and selectively hardened in the electric salt bath furnace. Two worm shafts at the right have been carburized and are ready to harden selectively on the worm end for 8 in. The two pilot bars are shown as quenched in brine. These are X1315, carburized to 0.060 in. depth, straightened from the quench, with an ultimate hardness of Rockwell "C" 62 plus. The two jack shafts of NE 8713 steel (carburized) have been quenched in a soluble quenching oil; they test Rockwell "C" 63-64. The clutch shaft, of NE 8749, is to be straightened from the quench at 550 deg. F. with an ultimate hardness of "C" 52-56. (Courtesy: Jones & Lamson Machine Co.)

Salt Bath Hardening of NE Steels

By LESTER J. SHEEHAN, *Production Metallurgist, Jones & Lamson Machine Co., Springfield, Vt.*

While the NE steels solved one of this country's nastiest critical materials problems for our war production planners, they introduced some that were nearly as nasty for the heat treater. One of these was the narrower hardening ranges of the NE steels, which means that temperatures and times have to be held within closer specified limits than with the conventional engineering steels. Electric salt bath furnaces are notably amenable to close control, and their use for NE steel treatment is described in this article.
—The Editors

MUCH THAT IS ANTICIPATORY has appeared concerning the performance and behavior of the NE steels. Their hardenabilities compare favorably with the S.A.E. steels they replace, but their hardening ranges do not, and the plain truth is that accurate, modern heat treatment methods alone permit the NE group to be used on jobs that were once the sole province of the high alloy steels. Nevertheless, because of refinements in heat treating which have been reflected in equipment and procedure, the NE steels are, we believe, here to stay. They have proved

themselves, and now it will never be said that metallurgical engineers have simply made a virtue of necessity. Some of the practice behind that conclusion may be of value.

The Jones & Lamson Machine Co.'s universal turret lathes, Fay automatic lathes, automatic thread grinders, radial and tangent die heads, chasers, and optical comparators involve over 40,000 heat-treated parts. That means provision for cyaniding, carburizing, annealing, normalizing and quenching in oil or brine. Other operations include stabilizing, tempering, oxidizing, straightening, cleaning, hardening, and surface treating high speed steel.

In this article we shall discuss neutral or salt bath hardening as typical, in view of the fact that martensitic structure and clean surface is sought so frequently in a wide variety of massive and small components, without or with the carburized case. Thus the neutral hardening section operates 24 hrs. a day, 7 days a week, and the salt bath is the busiest furnace in the plant.

The Parts Treated

Parts consist chiefly of shafts in all sizes and degree of complexity, from 1 to 10 in. in diameter and weighing up to 300 lbs. Rails and gibs are likewise hardened in salt. Some of the spindles are up to 33 in. in length. Both straight carbon and manganese carbon steels are utilized, as well as nickel-chromium, chromium-molybdenum, and tool steels. Representative parts, some of them carburized, selectively heated, or quenched in oil or brine, are shown in one of the illustrations.

Since many components are already gas carburized, a great deal of hot straightening is done, and the interrupted quench is frequently resorted to, withdrawing parts from the oil or brine quench at temperatures observed to mark the start of martensitic formation. The interrupted quench has also been found useful as a safety measure to prevent cracking.

Beginning with NE 8900 Series, medium hardening and full carburizing steels, progressive rulings by W.P.B. gradually brought the lower alloy NE 8700 Series and NE 8600 Series steels into use, and later on the NE 9400 Series, and the silicon-manganese steels, such as 9260. Heating by immersion in molten salt was found to be the best means of hardening them all. The silicon-manganese steels are especially subject to decarburization, yet we process gears of this type in salt with full surface hardness and no decarburization noted under microscopic examination. This is something that can be done in only a few specialized atmosphere furnaces, requiring much experimentation.

In this connection we have experimented with various types of atmosphere. We found that a reducing atmosphere was best, and yet decarburization was still noticeable. The atmospheres were formed from the products of combustion of city gas, and were adjustable from total oxidizing elements of 4 per cent oxygen to total reducing elements of 13 per cent carbon monoxide in a modern atmosphere generator with suitable control devices throughout. Despite the most careful handling, it was found that gears of 9260 steel could not be hardened successfully except in the salt bath.

We were recently faced with an interesting problem involving carburized NE 8713 die bodies which through error had been already finish ground prior to hardening, with a high Rockwell still required. The parts resembled a shaft fitted with a flange having a cross dovetail on the large outside face. Tolerances were so slight that it was at first doubtful if the group of pieces could be salvaged at all.

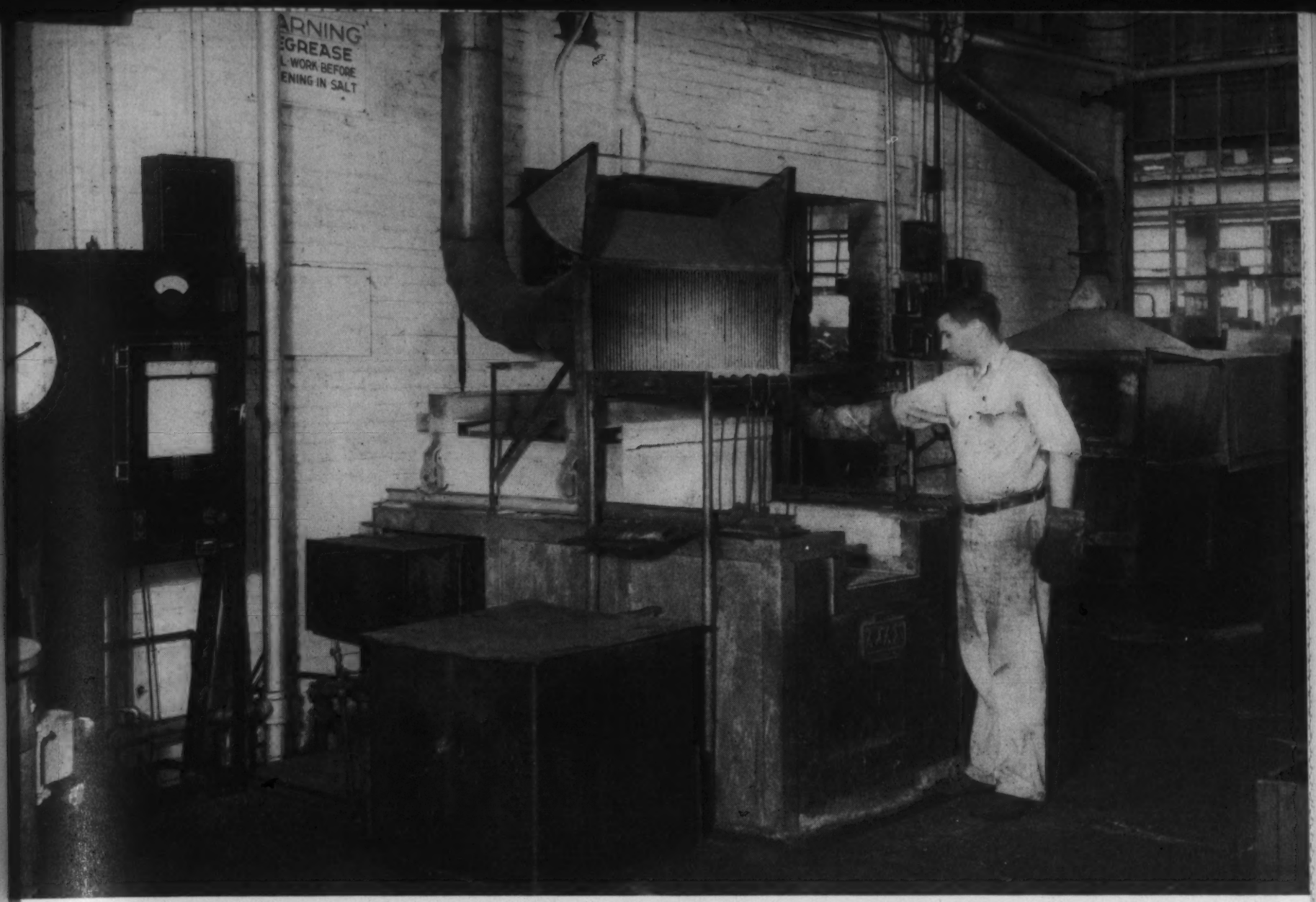
There was no other way to attempt it except by selective immersion in the salt bath to develop required full hardness at selected points. The parts were therefore suspended from spring tongs and heated in the electric salt bath furnace for 2 min. 50 sec. at 1425 deg. F., then quenched in oil, followed by a draw in oil at 235 deg. A uniform hardness of Rockwell "C" 65 was achieved by this method. Maximum distortion proved to be only 0.0002 in. runout, and the parts were but slightly discolored in the oil quench. This was normal because of the fact that pieces are protected in transfer from the bath by a thin film of salt adhering to the parts.

The Furnace and Its Operation

The salt bath furnace, installed 2 yrs. ago, is equipped with a refractory pot 40 in. in depth to accommodate long shafts suspended vertically. Electrodes, immersed in the salt to within 12 in. of the bottom for best results in this deep bath, are closely spaced and parallel. They both heat and circulate the salt by a visible electromotive stirring action. The furnace is a standard 60 kw Ajax-Hultgren unit, operating on 3-phase 60-cycle current at 230 volts. Temperatures used range from 1400 to 1600 deg. F. and up to a maximum of 1750 deg.

This furnace has operated without noticeable pot wear or other maintenance except for one electrode replacement a year ago, after 13,000 hrs. at full power input. A commercial neutral salt composed principally of a mixture of chlorides is used. It is kept to within 5 in. below the pot rim to allow for displacement without salt overflow when charges of large volume are introduced. This bath is sludged regularly, and temperature control is found to be within 5 deg. at all points within the bath. In connection with desludging, an effort is made to keep the furnace exterior, pot edges, top, and floor cleaned up at all times. This is done partly for psychological effect as well as safety considerations and the enhanced sense of sure control which always accompanies good plant housekeeping.

Thermocouples, within 27 per cent chromium-iron protection tubes, last 2 and 3 months each. They are checked by means of portable potentiometers and optical pyrometers. Depending upon the size of the parts, immersion periods in the salt bath will vary from a few minutes up to three-quarters of an hour. Time saved in this furnace is therefore important, since the same hardening operation by atmosphere methods requires a minimum total cycle of 1 to 2



Neutral hardening section. Operator is about to remove jack shaft, suspended from adjustable fixture support bracket by hooks. This view show quenching machine used in conjunction with salt bath furnace for quenching individual pieces on work-loaded jigs.

hrs. Large sections of 3 to 4 in. diameter are immersed for 45 min., of which 10 min. represent soaking at heat.

The furnace is equipped with a high fume hood to permit using the special cross bar suspension racks, adjustable in steps for height when special fixtures are suspended. These have been devised to hang from the racks so as to give proper immersion depths, and they are variously shaped to accommodate such parts as gears, worms, ratchets, shafts with hubs, gibs, etc.

Gear suspension is from the rod type of eyebolt fixture; ratchets and worms are similarly suspended. Shafts usually have tapped holes, and the rod suspension is used for big hollow shafts. Interesting Jones & Lamson fixtures are the 8-sided plates with eyebolts, and the cross-braced suspension hook with several removable plates drilled with different size holes to take care of parts from 1/4 to 3 in. diameter.

Parts are withdrawn from the bath still in their fixtures, using an electric hoist with overhead travel to the oil quench on heavily-loaded fixtures. Here the fixtures are hung in a basket to be plunged and lifted in the oil bath by means of a motor-driven gear reduction unit which revolves the yoke. This agitation quench bath is fitted with a circulating oil cooler, and temperatures are kept between 100 and 140 deg. F. The parts are withdrawn upon warning bell signal set up by an automatic timer, and they are held out of oil at the M_S point (start of martensitic formation), allowing thick and thin sections to transform at equalized rates of speed to prevent warping or distortion.

Individual timing devices of the solenoid type have been developed and installed for most operations in the heat-treating department. Their value is marked during high production, and we believe they should always be used with the NE steels. Likewise, while procedure for standard parts and choice of steels is now well established, a periodic check is made for black heat temperatures out of the quench, using thermometric salt sticks and recording the observations for check at least once per lot of parts, as a matter of routine.

After a wash in an alkaline bath, most parts are tempered in air convection furnaces at temperatures upward of 235 deg. as may be required, followed by airless abrasive blasting, Magnaflux, and hardness checks made on motor operated Rockwell hardness testing units. Fracture and microscopic examinations are found necessary only in the event rejects prove suspiciously high during normal inspection. This has rarely occurred. The commercial NE steels coming through today have been found uniform and predictable in their response to accurately controlled heat treatment.

Checking furnace temperatures with Leeds & Northrup optical pyrometer in the hardening section of Jones & Lamson Machine Co.

Many of the gears are finish machined on the teeth prior to hardening; others are recut, shaved, or ground after hardening. Tolerances on spline shafts are 0.002 in eccentricity O.D. On machined pieces which are wholly heat treated in the salt bath, distortion is invariably within tolerances, and no straightening is required. However, since many parts are gas carburized prior to liquid bath hardening, considerable hot straightening is done for accumulative distortion. Yet it is possible to handle 30 large pieces in the salt bath and to complete all operations including tests and final straightening within an hour on regular production.

Representative Practice and Results

Partly because of judicious fixturing, salt drag out and consumption is extraordinarily low, amounting to an average of 10 lbs. of salt per 1400 lbs. of work treated over a representative 6-month period on 24-hr. production, during which charges immersed and withdrawn from the salt bath furnace alone ran close to a quarter of a million pounds. Only one operator is assigned to the furnace per shift, handling work in and out and to the quench, but not tempering it. The charges vary in weight and handling, depending on the type. Some parts such as pinion shafts, clutches, rack bars, are selectively hardened. Shafts usually have hubs, and they may be partially or fully splined, frequently with threads at ends and centers. Gears up to 12 in. diameter are hardened in the salt bath.

It is obvious from the variety of parts that while no one part is altogether typical, the following is representative: A charge consisting of 24 transmission shafts, 16½ in. long and of NE 8713 carburizing steel is racked and suspended in the bath for hardening at 1425 deg. F. Each part weighs 4 lbs. 10 oz., and has already been carburized to 0.045 in. case depth. The total weight of the charge amounts to 111 lbs. The salt rises 2 in., and the temperature drop is about 85 deg. when the 111 lbs. of cold metal is first introduced. The full immersion cycle is for 45 min., of which 10 represent the period at hardening temperature. Time of quench in oil is about 2 min. Each part has 4 keyways and 7 different diameters from ¾ to 1½ in. Rockwell "C" uniform

in the as-hardened condition is 64 to 65, to be drawn back at 400 deg. to 56 to 61. The 24 parts are heated, quenched, wiped, tested for eccentricity and runout, and straightened hot to 0.005 in., all within 69 min., quenching two at a time.

Recognizing the comparative dearth of data with which the various NE specifications were tentatively introduced on a national basis during the middle of 1942, we have made an effort to check theory with actual practices observed to give optimum results. Virtually all methods of applying heat and quenching for every type of steel (over 90 different analyses) required by Jones & Lamson components have been tried. The only NE steels with which our experience is necessarily limited are the NE 9500 series.

Special Problems with the NE Steels

Generally, then, these lower alloy steels do give a completely adequate account of themselves in the field. It has seemed to us however, in the light of some trial and error experiences, that the importance of proper heat treatment methods and equipment has not been stressed in the literature. It must be recalled that time-and-temperature considerations, always subject to calculation on paper, are not abstractions. They have to be translated into suitable practice, and the fact is few plants can continue to "use it up, wear it out, make it do" in connection with equipment, even if alloy content is not further lowered. That is because it may be said without qualification that all the NE steels respond more unmistakably than their predecessors to smaller deficiencies in method or unknown variables throughout the heat-treating process.

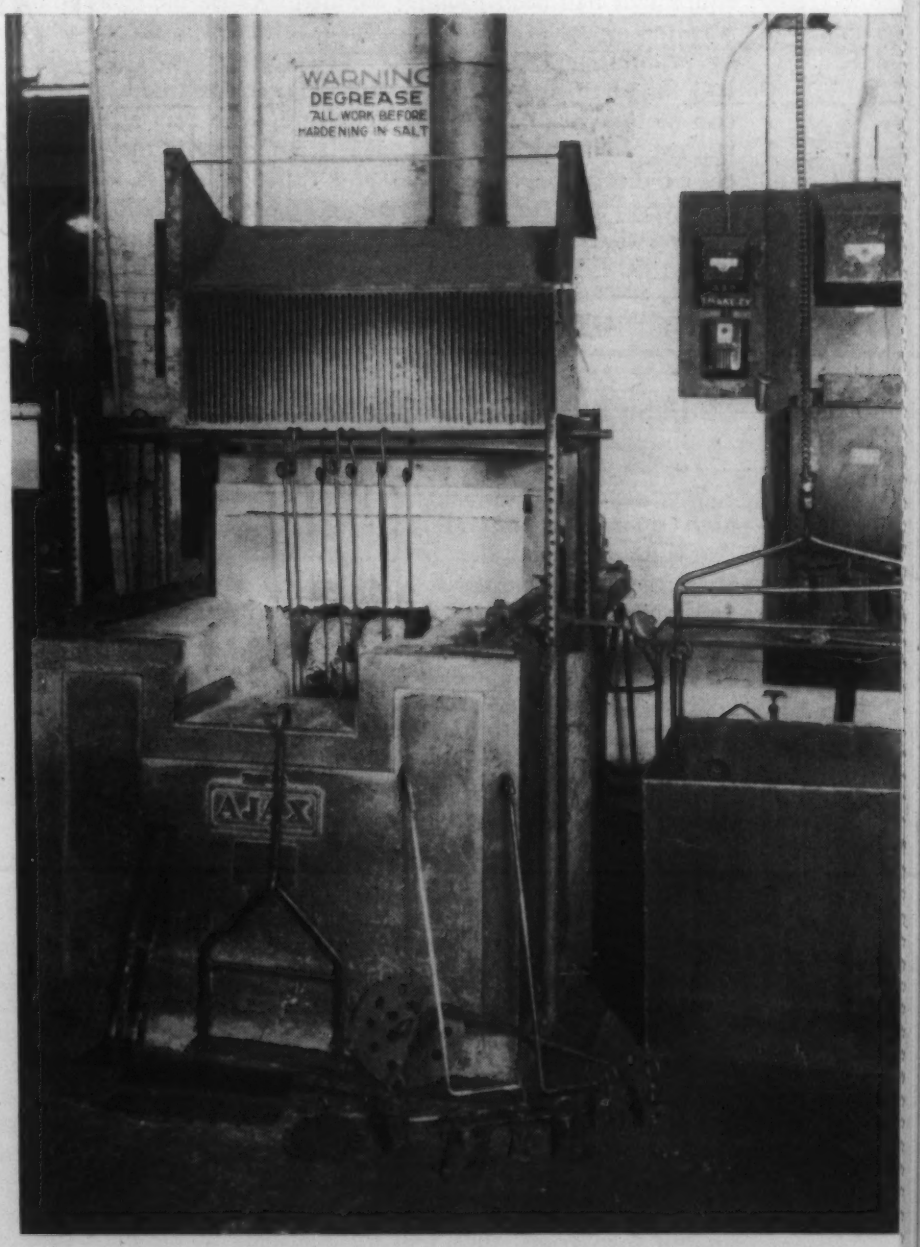
It has been found possible to overheat many of these steels within narrower limits as to temperature ranges at any time. Problems of grain structure, overall dimensional changes, and deformation of complex parts may intrude when the heating speed curve ascends too sharply. This means that the method by which heat is imparted cannot be neglected. Immersion in the liquid bath clearly introduces fewer variables than any other method, provided all recording devices are checked, the bath kept circulating for temperature uniformity at all points, and kept chemically neutral by proper cleaning.

Moreover, while circulating molten salt imparts heat very rapidly, it is interesting to observe that the salt bath method itself furnishes a natural protection against heat shock. When a cold part is first introduced in molten salt it momentarily cools the salt in immediate contact, and this cooled salt takes the form of a cocoon or contour sheath. If a part is quickly withdrawn, this sheath is seen to be of substantial thickness. Very shortly after immersion, however, this protective sheath has melted again, but the interval of its forming (about at the solidus point) has been long enough to protect the metal from the shock of a nearly straight-line heating curve speed. Thereafter, maximum heating speed is developed, and the heating rate in salt in some four times faster than by radiation on the overall cycle.

The NE steels are like all steels, subject to surface defects in the presence of all but perfect atmospheric conditions, hard to achieve day in and day out. It has seemed to us wiser to eliminate all atmospheric or chemical reactivity considerations wherever possible, rather than to attempt to control them.

Uniformity in tonnage quantity output can only be achieved by uniform heating methods, and such methods will give reproducible end products 24 hrs. a day. Negligible variations may then be attributable to the human factor which, as is well known, diminishes as the very perfection of a mechanism narrows responsibility beyond evasion. At least, this has been our observation, with less than 1 per cent average rejects attributable to heat-treating method or procedure, working almost exclusively with National Emergency steels, and hardening in the electric salt bath.

Special jigs and fixtures in use for neutral hardening operations at Jones & Lamson Machine Co. Close-up section of furnace shows adjustable height fixture support.



Letters to the Editor

Metal Reclamation

To the Editor: Some 20 yrs. or more ago, at a bronze foundry where tonnages were rapidly increasing, I authorized the purchase of a ball mill and concentrating table with the necessary accessory equipment for reclamation of foundry skimmings. Just at the time this equipment was delivered, it so happened that I was locating elsewhere, and by strange coincidence, there in the yard was an almost identical consignment of mill and table, waiting for installation for similar duty.

Accordingly, I proceeded with installation in the new locale and secured very satisfactory recovery of metal values. That the recovery product was found, in this instance, less valuable than had been anticipated, was in no wise the fault of the reclamation machinery or process. The method used was practically identical with that shown in the flow sheet you published on page 64 of your issue of July, 1943, except that a middling product from the table was returned to mill feed.

A year or two later, chancing to meet someone from my previous location, I learned that I and my reclamation equipment had been roundly damned because the concentrate was too dirty to use, or if made clean was accompanied by prohibitive tailing losses. The answer was clear—they had failed to provide for a middling, and as there was no-one at that plant, after my departure, who was at all conversant with any sort of beneficiation process, they simply closed down the little outfit and called it a loss.

I was told that a retrial of their installation, after making that modification, resulted very satisfactorily. Perhaps this experience may be of help to others.

ROBERT G. WOOD

Washington, D. C.

On Design of Non-Ferrous Castings

To the Editor: The war has brought American industry a very complex problem in providing substitutes for the high tin and copper alloys. Many interchangeability and "downgrading" studies have been made by all concerned. Prominent in these studies are figures for tensile strength and yield strength. This is very proper since any conscientious designer has a natural concern with the strength of the materials he is using.

It is the purpose of this letter to urge examination of the significance of these "strength" data. They give the reasonably expected strength of a given alloy in one very carefully-made standardized test specimen casting and are not in the least representative of the strength of the larger and irregularly shaped industrial castings made from these alloys. The castings are only as strong as their freedom from shrinkage. All of the bronzes have relatively high coefficients of expansion and casting shrinkage.

Further, due to their complex composition, many of them freeze over a very wide range leading to the segregation of weak low melting point constituents at interstices, and in some instances the dendritic network of high melting material forms so rapidly that the remaining liquid is excluded and cannot fill the interdendritic voids; furnace gases dissolved by the melt and released in freezing contribute greatly to this exclusion.

Then, to crown it all, the bronzes are much too fluid for our own good; they will fill out some of the most complex and irregular shapes yet devised by man. It is no wonder that, for as long as we have had the art of making bronze castings to contain liquids and gases, we have also had the art of "doping" them with anything from putty through litharge and glycerin, water glass and tin, and now we are even getting scientific about it and using modern plastics specially made for the purpose.

This is not meant to disparage the tensile test as an inspection tool; for this purpose it is quite useful, and will in general reflect serious departures from specified analysis or good foundry practice. It is to emphasize the fact that within very wide limits, the strength of a bronze casting is measured by its simplicity, the degree of recognition given in its design to the mechanics of alloy solidification, and the skill and knowledge applied to its founding.

The factor of safety employed in design must recognize not only the "tensile strength" of a given composition but also its shrinkage and drossing characteristics, its sensitivity to furnace gases and, above all, the shape of *the particular casting* under consideration. A simple casting of valve bronze may under proof testing prove to be much stronger than a complicated one of manganese bronze, or, leaving the factor of design constant, favorable casting characteristics of an alloy may outweigh differences of 40,000 or 50,000 lbs. per sq. in. "tensile strength."

We are asking our foundries to perform miracles and we are kidding ourselves about strength. It is time that we applied "science" to casting design (and founding, if you will) rather than to plastics to plug up the leaks.

WILLIAM B. BROOKS

2923 Rising Sun Road
Ardmore, Pa.

Sub-Zero Temperatures

To the Editor: In an article, in your July issue, I note your comment on page 53 in regard to the cost of electric current for operating a Deepfreeze unit as compared to the amount of money spent for dry ice. Your note reads "We wonder though if the higher original cost of the mechanical refrigeration has been included—Editor."

If you had asked this question, we would have very easily cleared this point up for you. This was an actual laboratory test that was made to determine the cost of extracting 1000 B.t.u.'s per hr. at —120 deg. F., as compared with the cost of extracting 1000 B.t.u.'s per hr. using dry ice. The matter of the cost of the equipment did not enter into this calculation at all. This is a pure savings on the cost of electricity for operating the Deepfreeze unit as compared with the cost of dry ice.

If you wish to go further into the matter of the total economies — for your information, the Deepfreeze —120 deg. Cascade industrial chilling unit sells for approximately $2600. This would be compared to the cost of the insulated chilling chamber required for efficient operation of dry ice. If the cost of such equipment would be amortized over a 10-yr. period, which is standard practice in many manufacturing companies, you can readily see that the cost of operating a Deepfreeze unit as compared to the cost of operating with dry ice for the same amount of work is still a very attractive saving.

M. R. CROSSMAN

The Cramer-Krasselt Co.
Milwaukee

METALS and ALLOYS

Engineering File Facts

NUMBER 27

November, 1943

PROCESSES AND PROCEDURES

Heat Treating

Salt Baths for Heat Treating

The various heat treating operations on both ferrous and non-ferrous metals are sometimes performed in baths of molten chemicals rather than in furnaces. Where the parts to be treated are small, temperatures must be very closely controlled, sections of the piece vary greatly in thickness, or surface finish must be preserved, salt baths are especially useful.

Salt bath treatment provides an alternative for atmosphere control in the furnace. Air is kept from the metal while it is being heated in the bath, and upon removal the adhering salt protects the surface. Heating is more rapid and more uniform in the salt bath than in most furnaces, although slow heating may sometimes be desirable.

The salt baths in use for heat treating may be classified according to reaction as neutral, oxidizing, or reducing, with the first type by far the most generally used. Neutral baths differ in composition according to temperature ranges desired, these being grouped into low, medium, and high temperatures.

Neutral Baths—Low Temperature

Low temperature baths operate in the range from 300 deg. to 1100 deg. F. They are used chiefly for tempering, steel bluing or blackening, steel quenching, brass annealing, heat treatment of aluminum alloys, etc. The salts used are usually nitrates and nitrites of sodium and potassium. Since these salts are readily soluble in water, the work is easily cleaned of any adhering material by washing with water. If the work has been cooled in an oil bath after the salt treatment, an alkali rinse will free it of both oil and adhering salt.

A thorough cleaning of parts to be heated in the salt bath is necessary to avoid contaminating the bath, with consequent thickening and sludge formation. Oil, salt or soot, having a reducing effect, should be carefully removed. Especial care is necessary if the work has previously been treated in a cyanide bath, as the cyanide may react rapidly, even explosively, with the nitrate-nitrite bath components.

Care must be taken that this bath is not overheated, as the salts may then attack the work, or the bath container material.

Medium and High Temperature Baths

The medium temperature salt baths of neutral reaction are chlorides or carbonates of potassium, sodium, calcium, and barium. Their usual operating range is 1150 deg. to 1650 deg. F. Baths of this type are used in the normalizing, hardening, or annealing of carbon steels and some alloy steels; in quenching and tempering high speed steels; and for heating brass, bronze, "nickel silver," copper, and gold for bright annealing. As carbonates tend to decarburize steel, the preferred compositions for heating this metal are mixtures of potassium and sodium chlorides. Sodium cyanide is sometimes added to chloride-carbonate baths which are used in steel treatment, to replace with nitride the carbon lost by decarburization.

While the chloride baths are neutral, they tend to oxidize with use, and may become reducing agents to the steel being treated. In order to prevent this decarburization, the products of the breakdown of bath materials are removed by addition of a rectifier to the bath. The rectifier is usually a compound containing boron, such as boric acid, borax glass, or boric oxide, which converts the oxides and carbonates to metaborates, to be removed as sludge. Additions of the rectifier to the bath should be made at regular intervals. Since the action of the rectifier is to combine with carbonates, it can not be used with those salt baths that originally contain carbonates.

High-temperature salt baths are used in the 1750 to 2350 deg. F. range. The principal use of these baths is in the hardening of high speed steel, although they find application also in the heating of metal for hot working and the heat treating of stainless steel. Compositions are of three general types—boric acid and borax; calcium, barium, strontium or other silicates; or calcium, barium or sodium fluoride and barium chloride. The borax types tend to dissolve iron, while the glass-like silicates are sometimes very difficult to remove from the metal parts after treatment. Melting ranges of these mixtures are usually from 1600 to 1900 deg. F.

Carburizing and Oxidizing Baths

Reducing baths are represented by the well known liquid carburizers, and are typically sodium or potassium cyanide, with the addition of an activating agent in the case of the activated carburizers. These have been described in an earlier issue of "Engineering File Facts" (No. 2, Feb. 1943). It need be pointed out here only that these cyanide baths can be used in the salt bath heat treatment of high speed tool steels as a step in the preheating of the work, or in certain types of quenching where the cyanide helps to remove the adhering salt from the high temperature bath.

Baths of an oxidizing nature are used for the annealing of the noble metals, and also find a use in the coloring of steel. They are operated at about 950 deg. F. and are low-priced.

Typical Practice

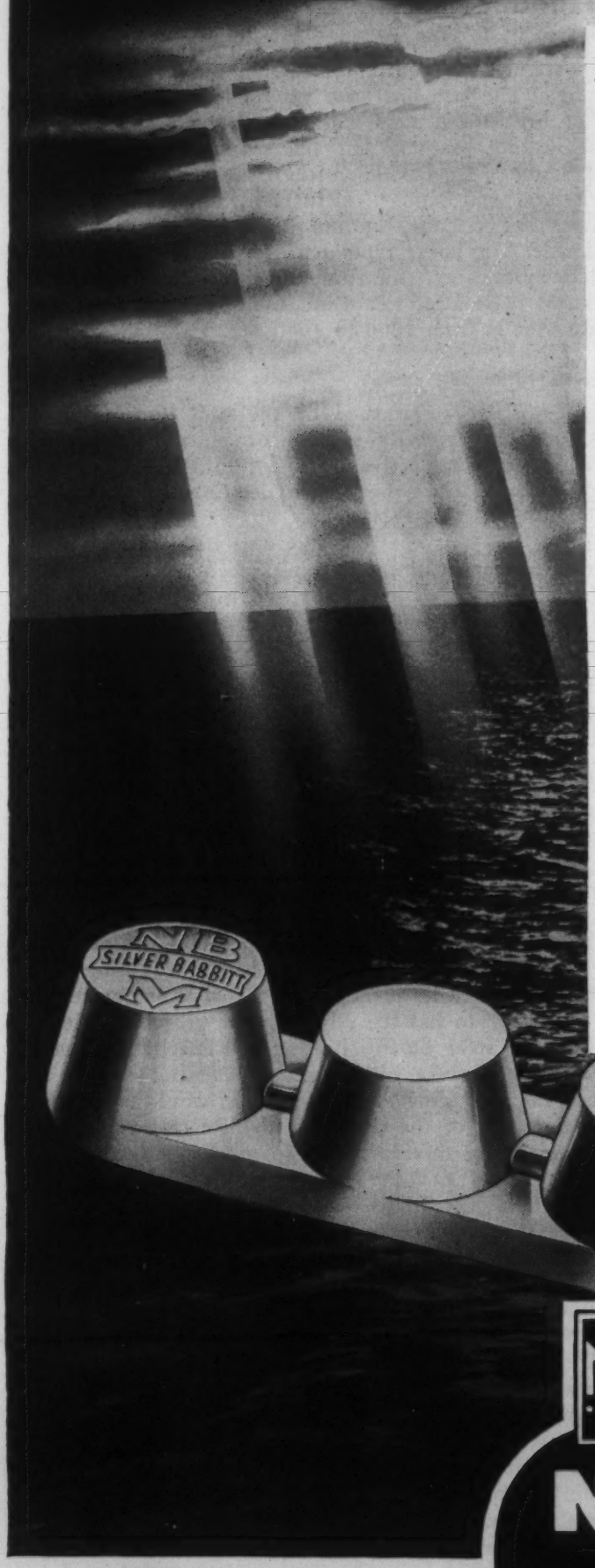
Heat treating operations may make use of a series of salt baths, starting with preheating, through high heat, and then to quenching. Care must be taken in such systems that the inevitable carry over from any bath will not unduly contaminate the next suceeding bath. Where this possibility exists, a "wash" bath may be interposed between the incompatibles. An example of this is found in the use of a cyanide bath for heating high carbon steel preparatory to quenching in a low temperature salt bath. The cyanide bath has the advantage of preventing decarburization of the steel during heating. Ordinarily the work might be quenched into a nitrite-nitrate bath, but because of the molten cyanide clinging to the metal this would be dangerous. A washing bath of the chloride-carbonate type might follow the cyanide bath, therefore, and to prevent a tendency to decarburization from 2 to 5 per cent of cyanide might be added. This concentration of cyanide would not be dangerous when completing the quench into the low temperature bath.

Typical of the use of a series of baths is the arrangement commonly used in heat treating high speed steel. The work might be placed in a muffle for a few minutes to heat it somewhat, and then placed in a preheating salt bath at 1450 to 1550 deg. F. A second preheating bath at 1850 to 1950 deg. F. might follow if the part were susceptible to cracking from too-rapid heating. High heat at 2100 to 2300 deg. F. would be the next step, and after soaking the required length of time the work would be quenched in brine, oil, or in another salt bath. A bright surface could be obtained also by quenching in a 5 per cent sodium cyanide solution, if the work would permit this treatment. A washing bath at about 1500 deg. F. might precede the low temperature quenching bath to help in the removal of the glassy high temperature salts.

Salt baths may be gas, oil, or electrically heated. A discussion of furnace equipment will appear in a subsequent issue.

Compiled by Kenneth Rose, Engineering Editor

A SILVER LINING FOR YOUR BEARINGS



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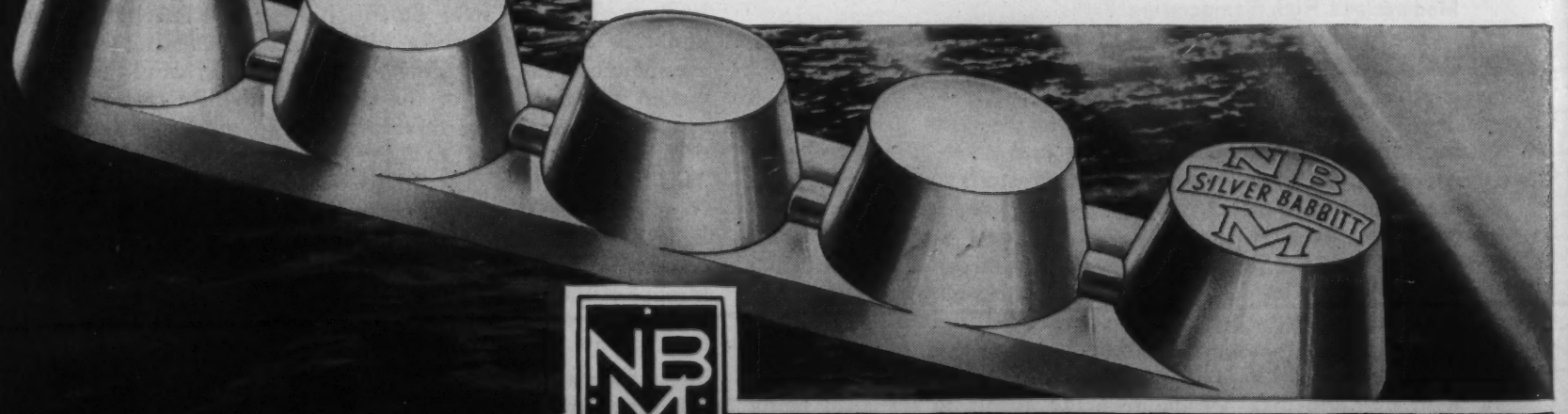
Relieves The Shortage of Tin-Base Babbitts

The Battelle Memorial Institute has authorized us to use their process for producing lead-base Babbitts with silver content. Although conceived to replace tin-base Babbitts, NBM SILVER is by no means a mere "substitute" It has relatively the same physical characteristics:

Retains hardness at high temperatures • Easy to handle and to bond • Resists squeezing-out at operating temperatures • Corrosion resistant.

Write for our new bulletin and engineering briefs.



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ST. LOUIS • NEW YORK

AMERICAN Brake Shoe COMPANY

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METALS and ALLOYS

Engineering File Facts

NUMBER 28
NOVEMBER, 1943

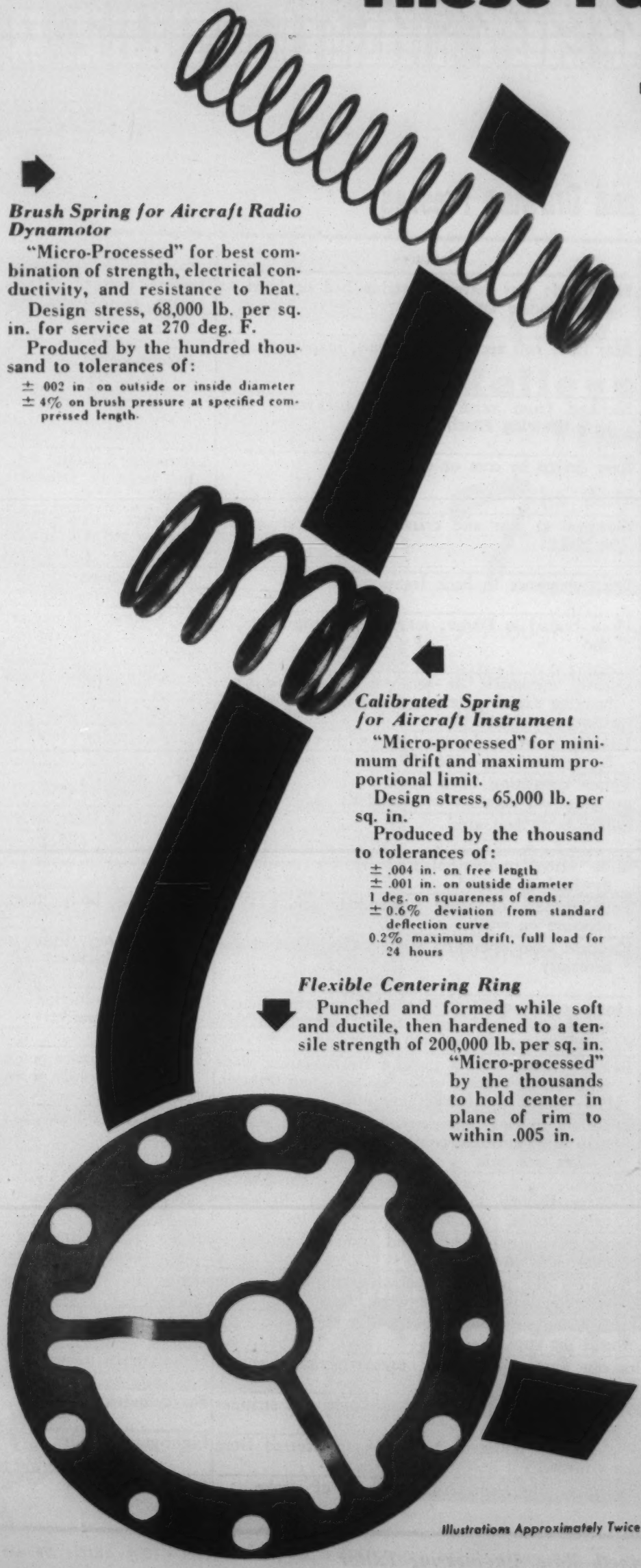
PROCESSES AND PROCEDURES
Stamping

Stamping and Drawing Presses

Machine	Size	Operations	Features	Uses
Foot Press	Small sizes only	Small work — single small holes, light stampings, embossing	Hand fed; may have adjustable bed or horn to accommodate large work	Jewelry, buttons, silverware, radio parts, etc.
Bench Press	1000 pounds to 12 tons	Embossing, stamping, etc., upon light material	May have roll feed, ratchet dials, magazines, etc.	Watch parts, novelties, jewelry, etc.
Inclinable Press	4 to 90 tons	Blanking, bending, stamping, forming, assembling	Inclined from vertical to 45° backward; may have drawing attachments	For light sheet metal
Open-back Gap Press	1 to 225 tons	Punching, shearing, cutting-out, trimming, forming, etc.	Ram driven by cam or eccentric	Automobile parts, etc., for large or irregular work
End-wheel Gap Press	Small to 50 tons	Blanking, forming, notching, piercing, cutting	Flywheel at rear and crankshaft at right angles to bed	For work with long, narrow strips of metal
Deep-Gap Punch Press	Medium sizes	Punching	Deep clearance in back frame	For wide sheets
Horning Press	10 to 100 tons	Forming, stamping, blanking, wiring, punching, riveting	Horn bolted to frame; may have swinging table also	For hollow cylindrical work, as steel drums, etc.
Double-crank Overhanging Press	Small	Blanking, cutting, piercing	Usually automatic or semi-automatic feed-over-hanging frame gives large die space—flywheel —or gear-driven	For large, light sheet metal
Notching Press	Small to medium	Cutting slots in edges of usually circular work	Usually short stroke machine, with work driven by rocker arm—450-650 strokes per min.	Notching motor laminations
Single- and Double-action Presses	Heavy	Shaping, blanking, forming, etc.	Frame consisting of a base, a crown, and two uprights tied together with steel tie rods	Heavy stock
Arch Press	Light	Cutting, trimming, shaping, blanking	Offers large bed area	For light, large area sheet metal
Double-crank Straight-side Press	To 2000 tons	Punching, cutting, bending, blanking, shaping	Slide often counter-balanced by air cylinder—flywheel or geared	Wide variety of uses in many sizes
Four-point Suspension Press	100 to 1500 tons	For large-scale deep drawing, etc.	Four corners of slide suspended, giving even pressure on work	Automobile body tops, etc.
Knuckle-joint Press	25 to 250 tons	Coining, upsetting, swaging, embossing, extrusion	Knuckle joint operating slide makes short stroke necessary	Coining money, light to medium thickness metals
Straight-side High Speed Press	10 to 400 tons	Blanking, stamping, etc.	Heavy construction to eliminate vibration—high speed roll feed, and scrap cutter, variable speed motor—about 400 r.p.m.	For high production with comparatively light metal
Dieing Machine	Small	Progressive die operation, etc.	Ram operated with a pulling stroke rather than a thrust, by vertical rods passing down through bed—about 350 strokes per min.	Electrical appliance parts, small automobile parts, etc.
Oscillating-die Press	Small	Blanking, cutting, etc.	Die-plate moves horizontally back and forth; strip fed through continuously. About 1000 strokes per min.	Small parts of light-gage material
Multi-slide Machine	Small	Combination of operations, as blanking, forming, bending, etc.	As many as 8 operations may be performed in succession by the different slides. Very accurate feeds. To 300 pieces per min.	Operations upon light-gage metal
Double-action Press	Small, medium or large	Blanking, drawing, etc.	Stock is successively blanked and worked by an outer and an inner ram	Applications requiring two related operations
Pillar Press	70 to 250 tons	Blanking, shaping, trimming, etc.	Subpress dies may be attached to the face of the ram for close-tolerance work	Light- to medium-gage work
Toggle Press	Small	Usually double-action, in which the outer slide holds the blank, and the punch, or drawing ram, forms the cup		Kitchenware
Hydraulic Press	To 1000 tons	High-speed pumping units can give this type of press operating speeds comparable to other large presses		Largest sizes of work
Horizontal Draw Press	Small to medium	Shell may be pushed through die for redrawing, or knockouts and stripper plates provided if shouldered		For cylindrical shells
Multiple-plunger Eyelet Machine	Small	Successive draws made by a row of plungers, the work transferred from station to station by finger conveyors		Light-gage shells
Rack-and-pinion Deep-drawing Press	10 to 30 tons	For long uniform redrawing operations with accurate length of stroke		Cylindrical shells

Compiled by Kenneth Rose, Engineering Editor

These Facts We Know to be True . . .



Brush Spring for Aircraft Radio Dynamotor

"Micro-Processed" for best combination of strength, electrical conductivity, and resistance to heat.

Design stress, 68,000 lb. per sq. in. for service at 270 deg. F.

Produced by the hundred thousand to tolerances of:

± 002 in. on outside or inside diameter
± 4% on brush pressure at specified compressed length.

Calibrated Spring for Aircraft Instrument

"Micro-processed" for minimum drift and maximum proportional limit.

Design stress, 65,000 lb. per sq. in.

Produced by the thousand to tolerances of:

± .004 in. on free length
± .001 in. on outside diameter
1 deg. on squareness of ends
± 0.6% deviation from standard deflection curve
0.2% maximum drift, full load for 24 hours

Flexible Centering Ring

Punched and formed while soft and ductile, then hardened to a tensile strength of 200,000 lb. per sq. in. "Micro-processed" by the thousands to hold center in plane of rim to within .005 in.

Illustrations Approximately Twice Size

THESE three beryllium copper springs may well be considered "fussy"—yet they were produced in the quantities noted—by the same production control routine used by Instrument Specialties Company on hundreds of less rigid but nonetheless important spring jobs.

These springs owe their success to "Micro-processing"—a precise technique by which the extraordinary spring qualities of beryllium copper are consistently predicted and controlled by I-S through every step of production, beginning with the spring wire itself.

Spring users are rapidly learning that they can expect more of their springs. As a result, many manufacturers are designing more service life into springs; are setting up and are obtaining closer tolerances and improved electrical qualities; are making steady use of our ability to control drift performance when necessary.

These are statements of fact which we can back up to the hilt. There is no better test of micro-processing than on your own springs—those now in use or on your drawing boards. Whether your requirements are as rigid as those illustrated or not, you can expect and will obtain improved performance and greater freedom of design when you use "Micro-processed" beryllium copper springs. You can prove these statements to your own satisfaction without obligation by sending samples or drawings to our engineering department.

INSTRUMENT SPECIALTIES CO., INC.

DEPT. M-2, LITTLE FALLS, NEW JERSEY

"MICRO . . . PROCESSED" I S BERYLLIUM COPPER SPRINGS

METALS and ALLOYS
Engineering File Facts

NUMBER 29
November, 1943

MATERIALS AND DESIGN
Steel Castings

Steel Castings

Types and Properties

Although casting as a metal forming process is very old, steel casting in the United States dates back no more than three-quarters of a century. Its steady growth indicates the many advantages which it possesses. In addition to the plain carbon steels, which show strength and uniformity characteristics as well as heat treatability, the alloy steels offer a wide range of properties, such as high temperature resistance, extreme strength, corrosion resistance, hardness, resistance to shock, etc. These properties are generalized in the accompanying table.

Carbon steel castings are usually allowed to cool in the mold until below the critical range, then are shaken out and cleaned, gates and risers removed, and the pieces either normalized or full annealed. The former treatment produces higher yield strength and ultimate strength, while the latter provides a softer steel more free of internal stresses. When maximum properties are required, an oil or water quench, followed immediately by suitable tempering, may be used.

Treatment for the alloy steels follows the same general pattern, but more care is necessary. They are usually shaken out hot, rough cleaned, and charged to the annealing furnace before they cool. A normalizing treatment is required to bring out maximum properties of certain alloy steels, especially those of high chrome content. Quenching and tempering variables depend upon the alloying elements and quantities.

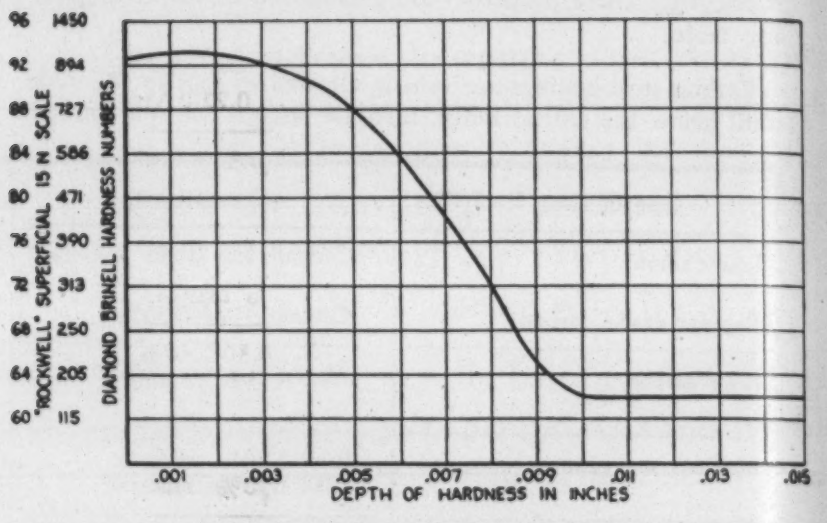
Type of Cast Steel	Composition	General Properties
Low-carbon	Carbon less than 0.22%	Special purpose steels. Grain refinement only heat treating result.
Regular grade carbon	Carbon 0.22-0.35%	The bulk of the steel castings made. Heat treatable.
High-carbon	Above 0.35% carbon	Phosphorus .06 to .07 per cent causes decided drop in charpy test. Heat treatable.
Medium manganese	0.20-0.50% carbon 1.0-2.0% manganese	Combines high strength and toughness.
Nickel-manganese	About 0.30-0.40% carbon 1.00-1.75% nickel 1.00-1.50% manganese	Carbon content may be higher to give added strength to hardness, or lower to increase ductility and toughness.
Silicon	0.75-1.50% silicon	High wear resistance, and good corrosion resistance.
Copper	0.90-1.50% copper	Raises yield point, increases tensile strength, hardness and corrosion resistance.
Nickel	0.5-5.0% nickel	High tensile strength, good ductility and impact resistance.
Nickel-molybdenum	0.50-2.0% nickel 0.20-0.60% molybdenum	Not widely used. Good strength characteristics.
Molybdenum	0.30-0.80% molybdenum 0.30% carbon up	Not widely used. High strength at elevated temperatures.
Manganese-molybdenum	0.90-1.75% manganese 0.15-0.45% molybdenum 0.25-0.35% carbon	Good resistance to creep, especially at elevated temperatures. Air hardening characteristics.
Molybdenum-vanadium	0.25-0.35% molybdenum 0.10% vanadium	Good strength characteristics. Developed for centrifugal casting of guns.
Vanadium	0.15-0.22% vanadium	Fine grained castings. Good impact resistance.
Chromium	0.50-1.50% chromium 0.40-0.50% carbon	Resistance to abrasion, high strength, moderate hardness.
Chrome-nickel	0.70-0.90% chromium 1.75-2.25% nickel 0.30-0.35% carbon	Most widely used of all alloy steels. High ductility and high yield strengths; high fatigue resistance. Good high temperature characteristics.
Chromium-molybdenum	0.70-1.10% chromium 0.20-0.40% molybdenum 0.20-1.00% carbon	High elastic ratio, good tensile strength and ductility.
Chromium-tungsten	4.50-6.50% chromium 0.75-1.00% tungsten 0.15-0.25% carbon	Corrosion resistance and good strength at elevated temperatures.

Compiled by Kenneth Rose, Engineering Editor

HARD

— and How!

Surface Hardened STAINLESS



Hardness penetration, 18-8 type stainless steel

with a Rockwell Hardness of 93 to 94 —"15-N" or equivalent to 67 to 70 Rockwell "C." That's the story on parts made from chrome-nickel or straight chrome stainless and hardened by

"THE *Industrial Process*"

Hardness penetration, 12-14% chromium type stainless steel

We haven't space enough on this full page to list all the applications where the combination of corrosion resistance and glass-hard wear resistance could be used to advantage. *But* show this page to the Metallurgist, or to the Design Engineer, or the Shop Superintendent or the Chief Draftsman —*he* will tell you.

Write us for complete details.

INDUSTRIAL STEELS INC.

250 Bent Street, Cambridge, Mass.

THE INDUSTRIAL PROCESS • FOR SURFACE HARDENING STAINLESS STEEL PARTS

METALS and ALLOYS

Engineering File Facts

NUMBER 30
November, 1943

MATERIALS AND DESIGN
Copper Alloys

Aluminum Bronzes

A Digest of Common Specifications

Name	Characteristics	Specifications	Form or Grade	Composition, per cent					
				Cu	Al	Fe (max.)	Sn (max.)	Mn (max.)	Others
95-5	These alloys are generally used for plate, sheet and strip and for hot forged parts; they have good corrosion resistance.	ASTM B124, Alloy 10	Copper alloy rods, bars and shapes	92–96	4–7	0.50	—	—	—
		ASTM B169, Alloy A	Aluminum bronze sheet and strip	92–96	4.0–7.0	0.50	—	—	—
90-10	The iron-free alloys do not have extensive applications except where high hardness and ductility are not needed.		Castings	88.00–91.00	9.5–10.5	0.20	0.50	—	1.0
90-9-1 (Grade B) and 89-10-1	This type of alloy is used for small castings (under ¾ in.² cross - section); centrifugal and sand castings and some forgings can be made; their corrosion resistance, strength and hardness adapt them to bearings, bushings, worm wheels and gears; 89-10-1 may be improved by heat treatment (grade 9B2).	SAE 68, Grade B	Cast aluminum bronze	89.50–90.50	9.50–10.50	1.00	0.2	—	0.5
		ASTM B30, Alloy 9B	Copper-base alloys in ingot form for sand castings	88.00 min.	9.00–11.00	1.25	—	—	0.5
		ASTM B148, Alloy 9B Alloy 9B2	Aluminum-bronze sand castings	88.00 min.	9.00–11.00	1.25	—	—	0.5
88-9-3 (Grade A)	Resistance to corrosion, to shock and to fatigue, great strength, and hardness comparable to that of manganese bronze characterize the alloys of this type; used for gun mount parts, gears, worm wheels, propeller and pump parts and for some types of bearings. These alloys can be cold-worked only slightly, but can be hot-forged and extruded over a wide temperature range. The wrought alloys of this type have the strength and ductility of medium carbon steel, and they have good corrosion resistance and may be hot or cold worked. Good bearing qualities, hardness, and resistance to shock and fatigue make these alloys useful for gears, bolts, propeller and pump parts, etc.	SAE 68, Grade A	Cast aluminum bronze	87.00–89.00	7.00–9.00	2.50–4.00	0.5	—	1.0
		ASTM B30, Alloy 9A-1	Copper alloy ingot for sand castings	86.75–88.75	8.50–9.50	2.75–3.25	—	—	0.5
		ASTM B148, Alloy 9A-1	Aluminum-bronze sand castings	86.75–88.75	8.50–9.50	2.75–3.25	—	—	0.5
		ASTM B150	Aluminum-bronze rods, bars and shapes	78.00–93.00	6.50–11.00	4.00	0.60	2.00	Ni 5.50 max.* Si 2.25 max.*
		ASTM B111 Aluminum bronze	Copper and copper-alloy seamless condenser tubes and ferrule stock	93.5 min.	5.00 min.	—	—	—	—
		ASTM B169, Alloy C	Aluminum bronze sheet and strip	90–93	7.0–9.0	0.50	—	—	—
		SAE 701	Wrought aluminum bronze rods, bars and shapes	78.00–93.00	6.50–11.00	4.00	0.60	2.00	Ni 5.50 max.* Si 2.25 max.*
Grade C	The addition of nickel and manganese produce as-cast physical properties very similar to those of the heat treated grade 9B-2.	ASTM B148 Alloy 9A-2	Aluminum bronze sand castings	78.00–86.00	10.30–11.20	3.00–3.75	0.20	3.50	Ni 5.00 max.
		ASTM B171, Aluminum bronze	Copper-alloy condenser tube plates	Rem.	8.00–11.00	1.50–3.50	—	0.50–2.00	Ni 4.00–7.00

When both Si and Ni are both present, only one shall be in excess of 0.25 per cent.

Compiled by Robert S. Burpo, Jr.

Consider the fourth dimension—TIME

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Today we are placing orders to make electrodes for shipment to you 4 to 5 months hence. It takes about 4 months from the time we place an order for the special stainless core wire before we receive it. After that, it's plain sailing to make the electrodes.

We know that we cannot expect all of our customers to know exactly what they will want 5 months hence, but we do believe that a large number of the users of Arcos electrodes have their work planned far enough in advance to give us their orders now. If a large percentage of your requirements could be placed sufficiently far in advance, we would be able to take care of both the large and the small orders on time.

I address this letter to you in that spirit of mutual cooperation which has long stood as the keystone in the relationship between Arcos Corporation and its customers and distributors.

May we have your major orders at least 4 months in advance?

Very truly yours,
ARCOS CORPORATION

R. D. Thomas

R. D. Thomas
President

METALLURGICAL ENGINEERING

shop notes

Arc Welding Ship's Ventilators

by W. A. Pruett,
Weber Showcase and Fixture Co.

Arc welding has had a field day in the making of cowl ventilators for Liberty ships at the Weber plants in Los Angeles. Being unable to buy a suitable 250-ton press, we built one by arc welding. Again,

after the blanks are cut and drawn, the two halves of the ventilator are welded together, bottom and face are trimmed and collars are rolled and welded for the vent.

It marks the first time that ventilators have been drawn on a press. Previously they have been formed by the "Lobster-back" method, involving riveting, which eventually weakens the structure due to the rusting of the rivets.

We designed and built completely by arc welding what we believe to be the world's largest deep-drawing press. It stands four stories high. When forgings for the four corner posts were not available, and delivery of specially-made forgings could not be assured in the allotted time, we turned to arc welding, using H-column construction, with structural steel.

In fabricating the two halves of the ventilator, a little experimentation revealed we could short-cut the more obvious process of using slotted pipe. We constructed a series of roller dies, which would form 11-gage steel ribbons into the desired shape. Six sets of rolls driving from the same gearing progressively squeeze the steel ribbon into pipe with a 1/8-in. slot. We then have a straight pipe to be rolled into a circle, causing the slot to close. Arc welding closes the loop.

Next, the welded ring is rolled over a tooth, which opens the slot once more. The strengthening ring now is driven with a hammer slotwise over the edge of the ventilator, and arc welded in place. Incidentally, this yields an excellent joint whose remaining cracks and crevices fill with hot zinc during galvanizing.

Similarly, a band of steel measuring 1/2 x 2 in. now is rolled and welded closed, slipped over the sleeve of the funnel and arc-welded. This band not only strengthens the structure as a whole, but readies the sleeve for attachment to the funnel proper at a later time. Welding the vent to the funnel may take place in our plant or at the shipyard. The former practice generally prevails now.

When the funnel is complete, we grind the weld and bead and sandblast preparatory to obtaining maximum results from the galvanizing job. Finally, screens are installed, thus serving the dual purpose of collecting debris and breaking the force of water when the ships are plowing through heavy seas. These ventilators are built to withstand the roughest usage.

We are making five sizes of round funnels, from 10 in. to 24 in., out of sixteen-gage cold-rolled steel, and the 24 in. and 30 in. ovals and 36 in. round funnels are of 14 gage.

[The above was condensed from a prize-winning article in *Arc Welding News* of Hobart Brothers Co., Troy, Ohio —Editor.]

If numbers are worn off micrometers, here's a method for repainting them: Clean graduations and figures with suitable cleaning fluid; apply black lacquer; wipe surplus lacquer from tool, leaving graduations and figures more distinct.

Informative Technical Bulletin, No. 10. War Production Board

Heat Treating High-Speed Steel

by Michael V. Chiovare,
Forge Plant, Dodge Div., Chrysler Corp.

To avoid the warpage and distortion sometimes occurring in heating high-speed steels, a double pre-heat, first at 1000 deg. F., then at 1525 deg. F., is advised. The steel should be soaked at the higher temperature, then quickly transferred to a temperature of 2225 deg. F. Furnaces with controlled atmosphere are preferred. If done in a furnace without atmosphere control, the metal surfaces should be coated with borax.

An interrupted quench is suggested when a hot quenching medium is not at hand. The piece should be cooled to about 300 deg. F., then placed in a draw furnace at 1025 deg. to 1075 deg. F. An air blast quench has been found satisfactory also, segregation cracks being minimized and hardness of Rockwell C-64 to 65 obtained.

Double-drawing of high-speed steel, to eliminate austenite, is recommended if tools show low hardness reading with usual methods of handling.

Store Scales Test Small Springs

by W. R. Ramsey,
Westinghouse Electric & Mfg. Co.

Technicians of the Westinghouse Chemistry Laboratories at East Pittsburgh, Pa., recently converted a store-type scale into an accurate device for testing small springs. It will accommodate tension

springs with a minimum length of 9/16 in., and compression springs with a maximum length of 3 in.

The load range is from 0 to 10 lbs. on the pointer scale, with a graduated beam of 10 lbs. and a blank beam of 10 lbs. Thus, the working range is 30 lbs.

A dial gage measures tension or compression, and a micrometer is attached to the moving head for testing springs at fixed lengths. Length checks may also be made with calipers. Total head movement is 2¾ in.

Cutting Magnesium: Wet vs. Dry

by A. E. Carpenter,
E. F. Houghton & Co.

Contrary to American practice, the English users of magnesium recommend dry cutting, even at high speeds, claiming that cutting fluids reduce chip recovery and that in present times this cannot be allowed. Experience in this country has indicated that in normal operations at high turning speeds fires will result if cutting fluids are not used.

Plants machining magnesium at high speeds and using cutting fluids in the recommended manner have practically no trouble with fires, while those machining at comparable speeds and machining dry do have chip fires.

While these fires are usually small and easily controlled, their presence is a hazard that can and should be removed. Experimental tests on chip recovery have shown that reclamation of clean oily magnesium chips is practically as efficient as that for dry chips.

Thus, from the standpoint of recovering metal, the use of cutting fluids is no real objection. While the English practice may have merit, observations in many large machine shops in this country indicate that the best machining practice for magnesium encourages the widespread use of cutting fluids.

In the interest of safety and maximum production, mineral oil-base cutting fluids conforming to the recommended specifications should be used in the machining of magnesium alloys if high cutting speeds are used or if the work must be cooled. The decision as to the use or non-use of cutting fluids must be made for each operation based upon the outlined conditions.

Cupola blocks and rough cut stone for relining cupolas were formerly shipped loose, which meant costly handling and poor storage methods. One large foundry gave orders to their suppliers to load blocks and stone on pallets or skids in neat piles, held together by steel strapping. This simplified handling for the supplier and the foundry — as one man with a lift truck easily moves 3,500-lb. loads at one time. Rehandling is reduced to a minimum, pallets can be loaded on top of one another, with floor space savings of 66 2/3 per cent. Freight cars of these packaged goods can be unloaded in under an hour.

—Process News,
Acme Steel Co.

Carbon Paste in Oxy-Acetylene Welding

by H. Griffith,
Linde Air Products Co.

For many welding jobs there is often the need for a fire-resisting compound that can be molded easily to any desired shape. Carbon paste is best, being superior to clay, plaster of Paris and other molding materials, since it does not stick to the metal, nor does it shrink or crack when heated. If there is a threaded hole near the break to be welded, it can be filled with carbon paste, thus preventing the oxy-acetylene flame from burning or otherwise affecting the threads, particularly if they are fine ones.

It is useful when building up metal around threaded or irregular-shaped holes, or when necessary to use a blowpipe between machined surfaces. It can also be used to protect gear teeth and other finished surfaces immediately adjacent to the section being welded.

Molds for odd shapes or pieces that have been broken off a casting can be quickly fashioned at the point on the main casting, where the break occurred and weld metal flowed in to form the desired shape. Building up a broken gear tooth is a common application. It reduces machining and finishing to a minimum.

Castings and other parts needing repair often have pieces of sizable proportion missing entirely. The combined problems of supplying the missing metal and keeping the part in proper alignment are often puzzling — but carbon paste will handle it.

Fixture for Mass Sharpening, Lipping

by Merrel Kern,
Caterpillar Tractor Co.

Formerly we sharpened and lipped one cut-off tool at a time. Then we devised a fixture that sharpened and lipped 30 at a time. Because of the large number

of tools used in our plant, the fixture has saved 5 hrs. per 24-hr. day, 30 hrs. per week, or 1500 hrs. per year.

The accompanying photograph shows the author and his fixture at work.

[Mr. Kern was honored by the War Production Board for this idea.—Editor]

Prolonging Life of Resistance Welding Electrodes

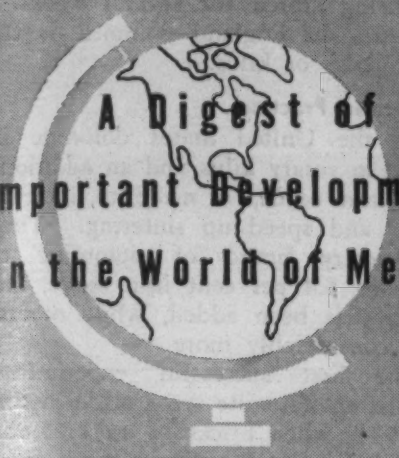
by H. D. Weed, Jr.,
P. R. Mallory & Co., Inc.

Much has been written on how to conserve the ordinary welding electrode, but perhaps not much on the resistance welding electrode. There are three main points to remember: First, use internal water cooling wherever possible, thereby eliminating "mushrooming," sticking and metallic pick-up. Properly cooled electrodes have a higher electrical conductivity and give more welds per electrode; they speed-up the output and produce sounder welds.

Second, use correct dressing technique. Spot-welding tips should be machined to the correct welding face on a suitable lathe. There is a tip dresser, a simple hand tool, that machines top and bottom electrodes simultaneously. All electrodes need reshaping after long runs to restore the correct welding face.

Third, clean electrodes frequently with an abrasive cloth, using light pressure. Tips, welding wheels, dies or mandrels that are contaminated — with iron particles, for instance — are apt to become burned or pitted.

Metallurgical Engineering Digest



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1 Metal Production

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Dolomite Refractories

Condensed from "The Iron Age"

Examination shows that much of the raw dolomite used is a true compound having a formula $MgCa(CO_3)_2$, dolomites richer in lime being mixtures of this compound with calcite. When this material is calcined, the carbon dioxide, CO_2, is lost and the product is a mixture of lime and magnesia.

Most important observation for the steel plant is that no mixture of MgO (magnesia) and CaO (lime) has a melting point lower than about 4172 deg. F. Unslagged shrunk dolomite or basic is therefore very satisfactory.

The $CaO\text{-}Fe_2O_3$ system is important since dolomite, when used in steel furnace, is always confronted with Fe_2O_3, either as a slag or as a vapor. Dicalcium ferrite and the mono-dicalcium ferrite have melting points of 2190 and 2550 deg. F. and therefore the iron oxide has a corrosive action even on straight basic. The particular part of $CaO\text{-}MgO\text{-}SiO_2$ system which is of major interest is the field on either side of the line joining MgO to $3\,CaO{\cdot}SiO_2$. It is also of interest to note that in stabilized dolomite clinkers the magnesia is present in the free state.

The $CaO\text{-}Al_2O_3\text{-}SiO_2$ system shows that the absorption of alumina by tricalcium silicate results in rapid drop in melting point. For this reason it is dangerous to allow dolomite brick and fireclay brick to remain in contact for long periods if the temperature is over 2370 deg. F. In the $CaO\text{-}MgO\text{-}Al_2O_3$ system it will be seen that even straight basic, alumina has a marked fluidifying action.

British dolomite deposits occur both in the Carboniferous and Permian systems. These pure rocks consist of an interlocking mass of crystals varying from 0.02 to 0.5 mm. diameter. The production of basic consists essentially of carrying out the reaction $(MgCa(CO_3)_2 \rightarrow CaO + MgO + 2CO_2$. The calcination must be carried on to about 3092 deg. F., when porosity drops to a low figure and material capable of being stored for several weeks is obtained. In England dolomite is calcined in cupolas or kilns.

American Practice

In the United States dolomite is calcined in rotary kilns and an addition, usually iron oxide, is made to increase stability and speed up sintering. Thus one proprietary brand of dolomitic clinker contains 5.4 per cent iron oxide, most of which has been added, while others contain considerably more.

The first successful experiments on stabilizing dolomite were made in England in 1934, when bricks of a 75:25 mixture of dolomite and sudamite were found to give good results in open-hearth furnaces. Bricks which hydrated contained small amounts of uncombined lime owing to insufficient silica or inadequate firing, while those which dusted after use contained gamma dicalcium silicate. This emphasized necessity of adjusting the chemical composition. Therefore the principle constituent should be tricalcium silicate and magnesia. Some early semi-stable types of dolomite brick gave good service in steel works. Somewhat more stable brick can be made by adding a flux to the batch and firing the brick in the ordinary way, while the life of such brick in storage can be extended by boiling them in pitch after firing.

With stable dolomite brick, the various grain size fractions obtained by grinding rotary kiln clinkers are recombined by weighing out fixed quantities of two or three grain size fractions. These are mixed with water in a paddle type mixer. Water content of the batch when used in hydraulic press is about 4 per cent. Molding pressure is 10,000 to 15,000 lb. per sq. in. Firing is done in down-draught kilns, using coal, oil or producer gas as fuel. Maximum temperature is 2462 to 2642 deg. F., and lasts at least 24 hrs. This method of firing is used in England and differs considerably from the American method.

Analysis of semi-stable dolomite used in England is: Silica, 4.27 per cent; ferric oxide, 2.53 per cent; alumina, 2.16 per cent; lime, 51.66 per cent; magnesia, 38.21 per cent; and loss on ignition, 1.07 per cent. The analysis of stabilized brick is: Silica, 14.44 per cent; ferric oxide, 3.44 per cent; alumina, 1.50 per cent; lime, 40.04 per cent; magnesia, 40.30 per cent, and loss on ignition, 0.25 per cent. Thermal conductivity of stabilized dolomite at 1832 deg. F. mean is about 15 B.t.u. Specific heat over a range of

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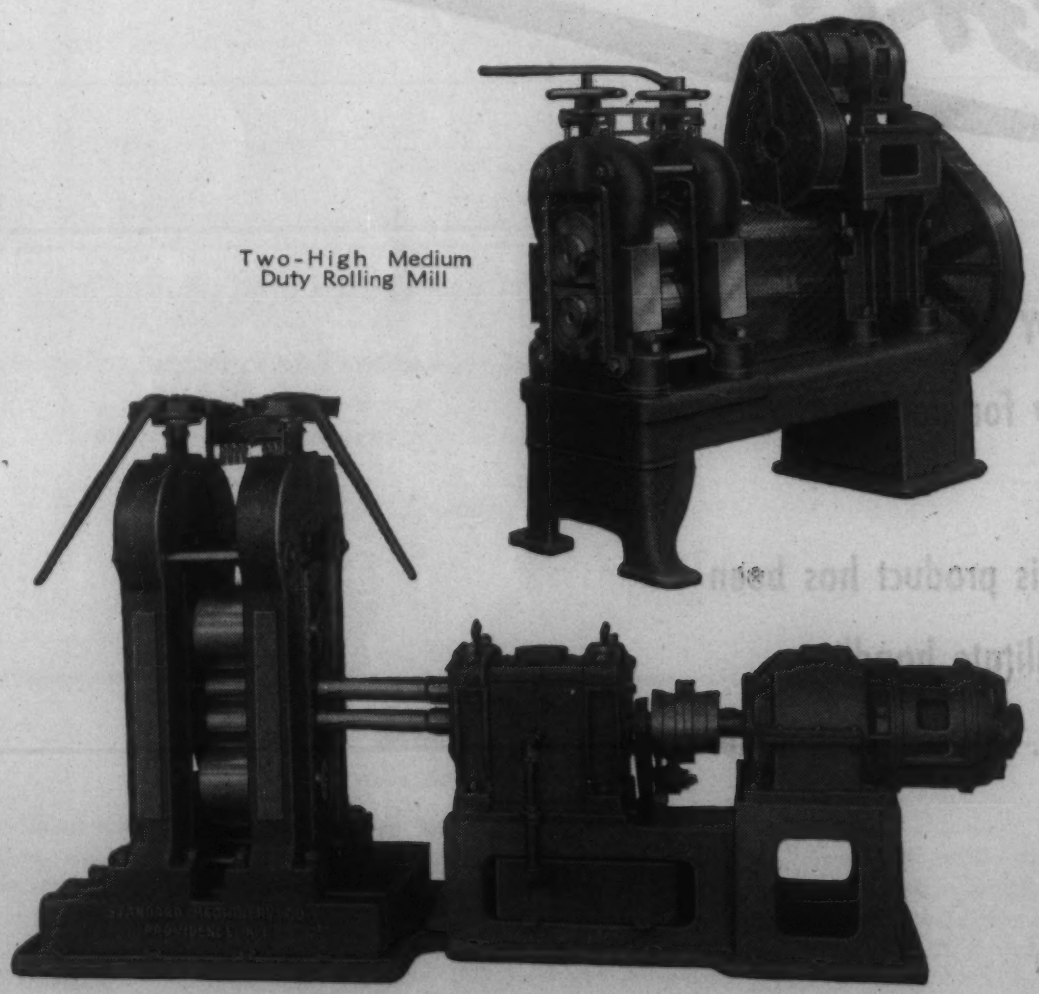

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1402 to 68 deg. F. is 0.255. Slag resistance to molten steel is good.

The analysis of dolomite-magnesite brick is: Silica, 11.36 per cent; ferric oxide, 3.24 per cent; alumina, 1.60 per cent; lime, 31.40 per cent; magnesia, 51.60 per cent; and loss on ignition, 0.14 per cent Stabilized dolomite brick gives service equal to magnesite when used in basic open-hearth furnaces. In arc furnace bottoms they give service equal to straight magnesite. Semi-stable bricks give excellent results in side walls of arc furnaces.

—J. H. Chesters, *Iron Age*, Vol. 152, Aug. 5, 1943, pp. 48-53; Aug. 12, pp. 86-89, 150. 152.

Pouring Brass

Condensed from "Chemical Age"

Billets of 60-40 brass may be produced from a variety of scrap metals and alloys. Scrap should be free from oil cutting lubricants, treated magnetically, and baled or briquetted. Lead should be added to the charge as a secondary alloy, preferably as a 60-40 copper-lead alloy. The charge should be stirred well before pouring and skimmed immediately prior to pouring. Melting should be as rapid as possible.

Pouring temperatures between 1040 and 1080 deg. C., (1900 and 1975 deg. F.) are desirable, with the high side preferred. Cold pouring results in a number of defects such as cold shuts, porosity, and "blowing." The billet should be poured as quickly as is compatible with a sound interior, and this speed should be carefully regulated and maintained. The mold should contain sufficient metal to insure a chill casting. Slow cooling is detrimental to the physical properties of the billet.

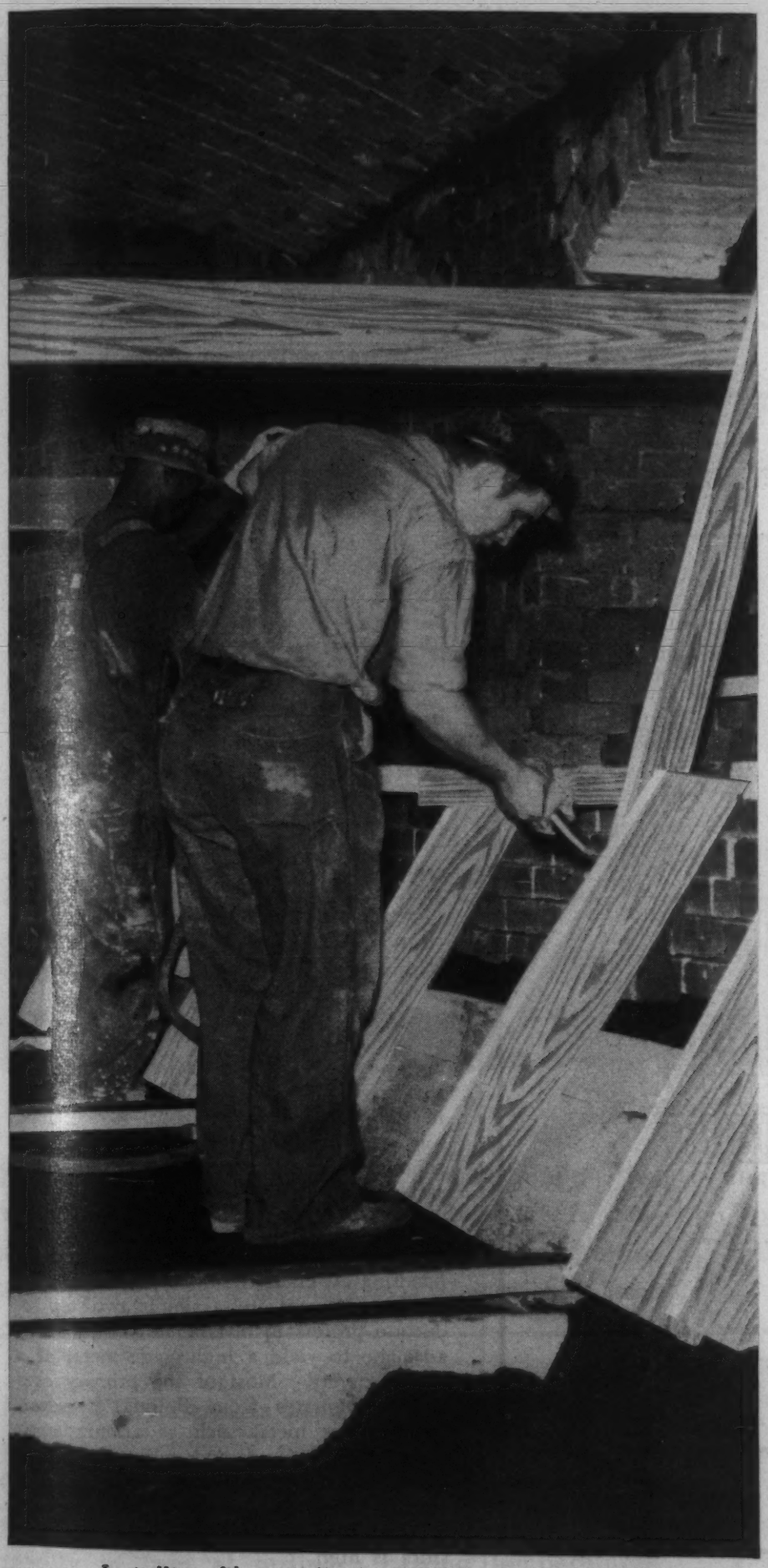
Ingots of 70-30 brass must be made from the purest and cleanest scrap. It is advisable to use at least 30 per cent virgin metal in each melt. Copper is first introduced into the crucible or furnace, then the scrap, and, shortly before pouring, the spelter. The charge should be melted as quickly as possible, kept covered with a layer of stick charcoal or flux, mixed well, and skimmed carefully before pouring. The correct pouring temperature is 1100-1150 deg. C. (2000-2100 deg. F.).

Modern practice is to pour into vertical molds through runner-boxes. Correct speed is maintained by flushing molten metal quickly into the runner-box and maintaining a feeder head of 3-4 in. throughout the pouring operation. A recommended speed of rise within the mold when casting an ingot 12 in. wide by 1¼ in. thick is 1½ to 2 in. per sec.

Final feeding should be done carefully. Some metal should be allowed to overflow at the end of the pour so as to carry off any skim which may pass through the holes in the tundish. The design of the mold should insure chilling the casting as much as possible.

For producing 90-10, 97-3 and similar alloys, only virgin metals or process scrap should be used. The charge should be melted as quickly as possible and kept covered with stick charcoal. Shortly before pouring, the melt should be deoxidized—

RAMIX is helping make that extra two million tons



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EVERY day, in many ways, Ramix helps open hearth and electric furnace men to "keep 'em rolling". . . to make that extra steel the war agencies are calling for.

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Every superintendent will find a dozen or more ways in which this chemically-bonded, cold-ramming magnesia refractory can be used to advantage. Basic Field Engineers suggest uses, too. Busier now than ever, these service men are never *too* busy to lend you a hand when you want help or advice on basic hearth refractories. We're in this with you to make that extra steel for the 1943 goal.

BASIC FURNACE

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CLEVELAND, OHIO

usually with a phosphorus-copper alloy. The amount of phosphorus added should be carefully calculated, allowance being made for that contained in the scrap. The ultimate phosphorus content must be kept below 0.005 per cent.

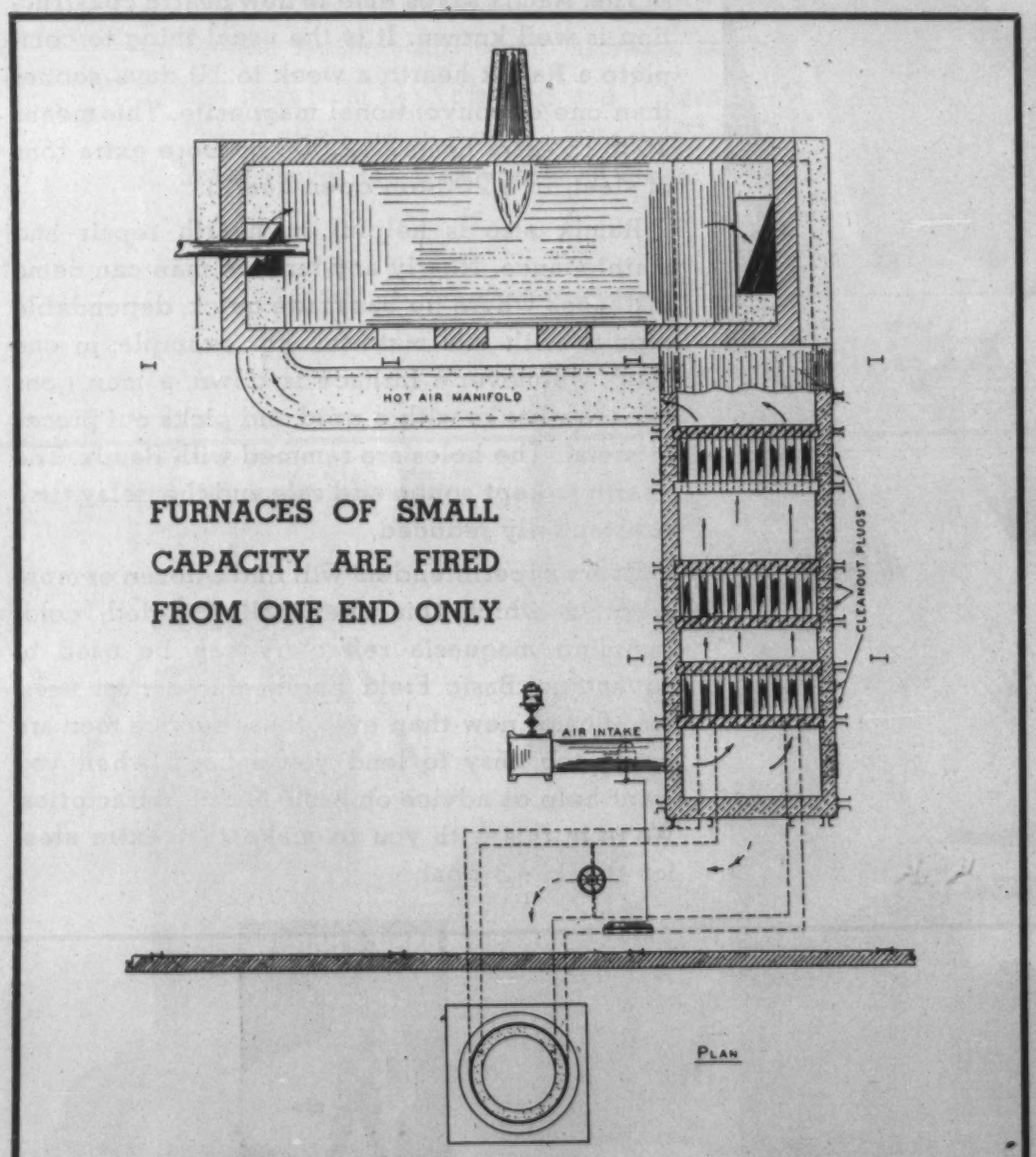
The pouring temperature should be about 1200 deg. C., (2200 deg. F.), and a pouring speed up to 2½ in. per sec. is recommended for an ingot of 12 in. by 1¼ in. cross-section. Where vertical mold and runner-boxes are used, the latter should be made of nickel-chromium cast-iron. Final feeding should be done even more carefully than in the other cases. An ideal design of the mold should embody vertical pouring, use of runner-boxes or tundishes, quick removal of the ingot, and accessibility for cleaning. The "book" type seems to be the best for strip molds. In billet production, a gentle taper towards the bottom is the most practical.

The most commonly used material for molds is cast-iron, because it is easy to mold and machine, is hard, and warps very little. However, after a number of casts it has a tendency to develop surface cracks, which eventually render the molds unfit for use. The life and performance of molds can be improved by using only the best pure hematite iron, adding a little steel to the iron, or using nickel-chromium cast-iron. Machining the casting face is advantageous, particularly when alloy cast-iron is used. When molds have been used for any length of time, another light machining of casting face will improve the life of the molds and the surface of cast ingots.

Dressings for protecting the face of the mold and for producing a flame to exclude all air from the mold during pouring should be capable of being applied to a mold with a temperature of 100 deg. C. (212 deg. F.), or slightly more, without breaking down on drying; should not leave a hard deposit difficult to remove and apt to build up; should burn quickly when in contact with the molten metal and should contain no moisture.

—*Chemical Age*, Vol. 49, Aug. 7, 1943, pp. 139-141.

"FITCH" RECUPERATORS For OPEN HEARTH



WHY REVERSE?

FITCH RECUPERATOR CO.

PLAINFIELD NATIONAL BANK BLDG. PLAINFIELD, NEW JERSEY

Tin Smelting in the U. S. A.

Condensed from "Mining and Metallurgy"

Although the United States uses more tin than any other nation, there is no shortage for essential war purposes because of strict control, the increase in the amount of secondary tin available, and the early purchasing of tin and tin ores for stock-piling. Before the war, tin was not smelted here on an important scale, since the Dutch and British could produce metal of high purity much more cheaply.

With the Dutch smelters in enemy hands and no certainty that English smelters would not be destroyed, plans were made for the construction of the Longhorn Smelter. Negotiations with Bolivia provided an adequate amount of concentrates. Construction and operation of the smelter were put in the hands of the Billiton Co. because of its success in Holland. A site in Texas on the Gulf was selected as providing low fuel costs and cheap hydrochloric acid. The building was started in Oct. 1941 and the first tin came from the furnace on April 5, 1942.

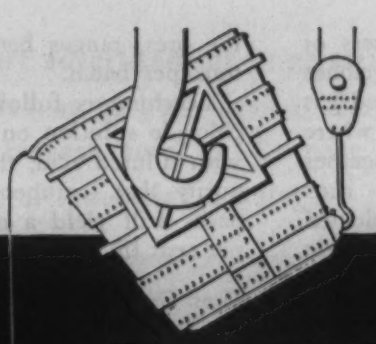
When Singapore and Penang fell into enemy hands, the smelter was expanded so that now it can turn out all the tin needed in the United States—about 50,000 long tons. As long as we continue to receive supplies from present sources we are in a safe position.

Process

The Longhorn Smelter is constructed for handling all grades of tin compounds. For the pure alluvial ore, a simple two-step reduction process in reverberatory furnaces is adequate to yield a high-grade metal at a high recovery. Most of the primary ores and concentrates from Bolivia, however, contain base metal such as arsenic, antimony, copper, lead and bismuth and in addition excessive sulphur. The iron content is often too high for direct smelting and in the low grades, the percentage of silica is high.

Most of the ore comes under the classification in which the silica content is less than 10 per cent. It is calcined in Unax kilns with or without a reducing agent or common salt, the iron and other impurities becoming soluble in hot hydrochloric acid. The hot calcined ore is cooled to room temperature in water-cooled cylinders with air excluded to prevent reoxidation.

Malleable Irons find use for



FERRO-BORON

Strength and toughness are the special qualities for which Malleable Iron is valued. Research is constantly employed to make these physical properties more dependable; and engineers govern their uses of Malleable Iron accordingly.

A recent advance has been the addition of Boron to the list of alloying elements. The Molybdenum Corporation, being a very large producer of Boron alloys, has developed a Ferro-Boron which dissolves readily in iron at ordinary casting temperatures, without elaborate preparation, and under standard foundry procedure.

Inquiries are invited on any use of Molybdenum, Tungsten, or Boron, and specifically on the use of Ferro-Boron for the improvement of Malleable Irons.

AMERICAN Production, American Distribution, American Control—Completely Integrated.
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Sales Representatives: Edgar L. Fink, Detroit; H. C. Donaldson & Co., Los Angeles, San Francisco, Seattle.

MOLYBDENUM CORPORATION OF AMERICA

GRANT BUILDING PITTSBURGH, PA.

MCA

The dust resulting from the fineness of the ore is precipitated in Buell cyclones and returned to the kilns. The cooled gas is treated in a Cottrell installation where the remaining dust is precipitated together with the fumes. This precipitate runs high in antimony and arsenic. The calcined material is leached with hot hydrochloric acid, in spherical digesters having a rubber lining protected by two layers of acid proof brick. Steam is supplied through one of the hollow trunnions. Slow rotation of the spheres agitates the ore continuously and obtains high elimination of impurities. The time varies between four and eight hours and the capacity of the digesters, depending on the specific gravity and iron content of the ores, ranges between eight and eleven tons per batch.

Leaching is followed by filtering of the chloride solution on Nutsh filters. Washed with diluted acid, the residues are of such purity that treatment in reverberatory furnaces will yield a metal of at least 99.80 per cent tin, meeting the S-14 specifications.

Ores Grouped

Medium and low-grade ores, containing excessive amounts of gangue and iron compounds, are in two groups. In the first, the percentage of base metals is so low that direct smelting will yield a hardhead from which pure metal may be produced. In the other, where metallic impurities are too high, a roasting and leaching process has to be used first. Generally after this treatment the residues yield high-grade concentrates on jigs and tables in the dressing plant. If not, they are re-treated yielding a residue ready for smelting. Usually it pays to smelt the tailing of the dressing plant to a final slag with a low tin content from which common tin can be recovered.

Smelting of all concentrates and clean residues is done in two steps in reverberatories fired with natural gas. In the first, the amount of reducing agent is limited, so that metallic tin practically free of iron is obtained. The slag still carries considerable tin. In the second, the primary slag is further reduced to a low tin content in the final slag. A great amount of iron is reduced simultaneously, forming an alloy with the tin, called hardhead. Containing over 80 per cent tin, this hardhead is treated simultaneously with the ore in the first operation, the iron acting as a reducing agent.

The metal produced by the primary smelting is tapped in floats and transported in poling kettles in which it is refined by steam. After stirring and skimming, it is ready for casting. Some of the tin volatilizes and is carried with the exhaust gases to the Cottrell installation. There it is precipitated and returned to the reverberatory furnaces.

High prices and scarcity warranted the construction of a dust precipitation plant from which recovery will be better than 99 per cent. Losses appear in slags containing about 1 per cent tin. Treatment of the waste solution, to recover the tin converted into tin chloride, is contemplated.

—Charles B. Henderson. *Mining & Metallurgy*, Vol. 24, April 1943, pp. 196-200.

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Before we tell you about Soda Briquettes, may we remind you that *America needs your help every day?* It may mean working a little harder or longer on the job . . . avoiding the waste of critical materials . . . giving up some spare time to Civilian Defense activities . . . being a Blood Donor . . . saving in War Bonds instead of spending for non-essentials. Each day presents its opportunities for being a better American. We sincerely urge you to take advantage of them.

And now—Soda Briquettes. They're proving their effectiveness every day in desulphurizing iron, quickly and cheaply. Substantial reductions are being recorded depending, of course, on the height of original sulphur; the amount of material used per ton of iron; the amount of contact produced between iron and treating materials.

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COLUMBIA CHEMICAL DIVISION

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Supercharged Blast Furnace

Condensed from "Archiv Eisenhüttenwesen"

In previous experiments, R. Durrer had observed that when coke was burned with pure oxygen there was a considerable amount of carbon dioxide in the products of combustion. The explanation offered was that the quantity of gas formed was too small to raise the temperature of the surrounding zone to a point sufficiently high for reduction of the primary carbon dioxide to carbon monoxide to take place.

The present authors describe a further investigation of this subject using a small shaft furnace 20 cm. (.66 ft.) in diam. with two tuyeres, a coke with 1.1 per cent of ash, and blast in which the proportion of oxygen was 21, 42, 66 and 100 per cent in different tests. Contrary to the previous observations, it was noted that increasing the proportion of oxygen in the blast promoted the reduction of carbon dioxide to carbon monoxide. The rate of this reaction depends greatly on the temperature, other conditions being equal.

The reaction rate in the first stage (that of carbon dioxide formation) is slower with air only than with oxygen-enriched blast. A high initial temperature has a greater effect on the reduction of the carbon dioxide than a steep temperature drop.

The experiments indicate that it would be possible to operate a low-shaft furnace with an air blast the gases from which would consist of nitrogen and carbon di-

(Continued on page 1119)

THIS is a reprint of a Corhart advertisement in glass-industry magazines. But perhaps it will give you an idea as to how Corhart Electrocast might serve YOU. For further facts about Electrocast, turn to "Corhart," in either the Chemical Engineering Catalog, or the Metal Industries Catalog.

Re-paved Electrocast Bottom Saves Major Repair!

SOMETIME ago we published the case history of a working-end in which an old and badly worn clay bottom had been re-paved with Corhart* Electrocast, and how the Corhart sidewalls had thereby been saved for at least another campaign.

Above we show a photo of that paved working-end bottom after one fire of approximately 24½ months. Note that the paving is "just as good as new"—and that after a few minor changes in sidewalls, the furnace is ready for another run! Practically no wear on the Corhart paving is apparent, and it is believed that the construction has and should contribute to improved glass quality.

Thus the Corhart Electrocast re-paving has now again saved a major repair—the original Corhart working-end sidewalls have now served for four fires approximating 7½ years—and the operator has saved the time, the materials and the PRODUCTION that would otherwise have been lost by destroying and replacing the old working-end bottom and sidewalls.

The economies represented by this type of installation are so obvious that every glass manufacturer should be interested when he knows the facts. These facts we would be glad to discuss further with you. . . . Corhart Refractories Co., *Incorporated,* 16th and Lee Streets, Louisville, Kentucky.

*Not a product, but a registered trade-mark.

QUALITY · ECONOMY · ENDURANCE

CORHART ELECTROCAST REFRACTORIES

FOR THE ALUMINUM INDUSTRY

Taylor ZIRCON HEARTHS

produce cleaner metal

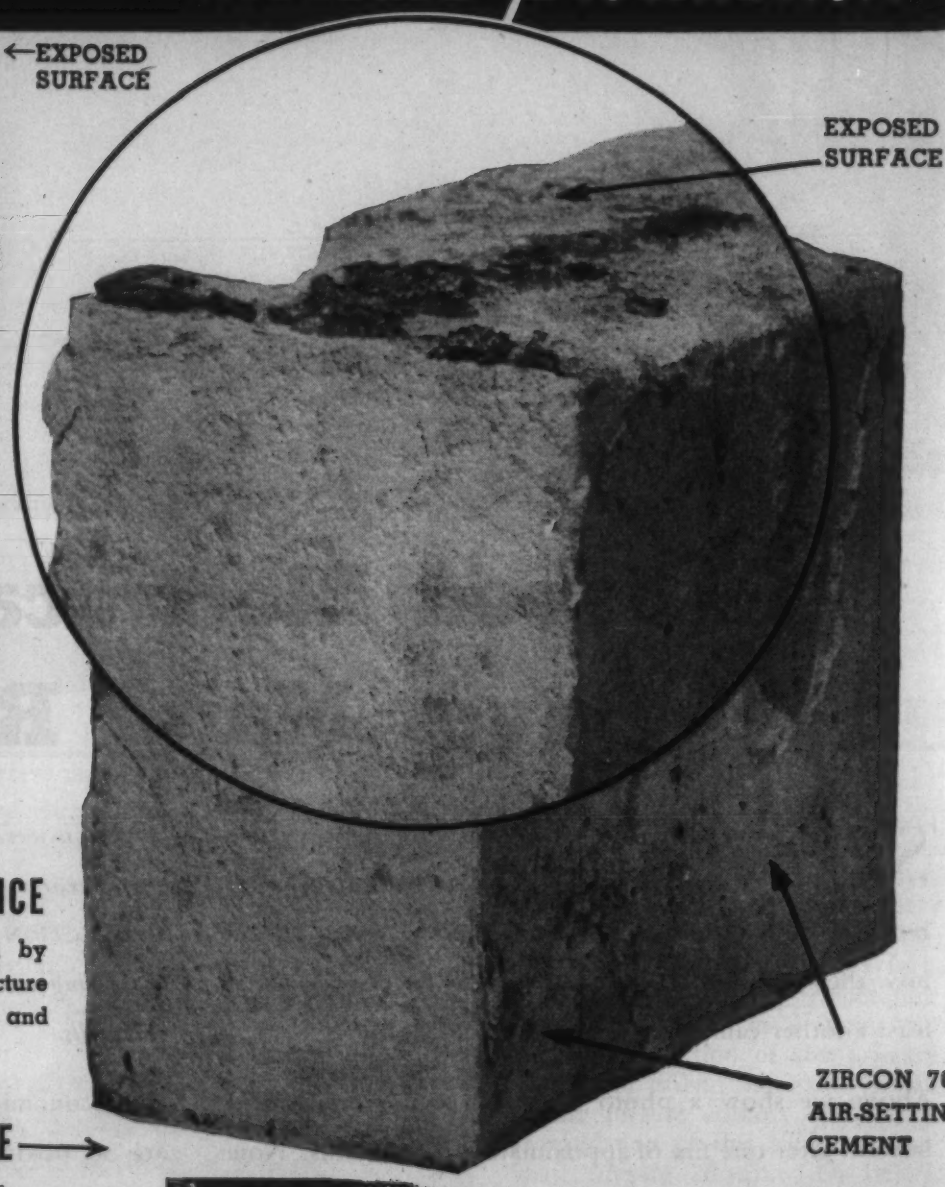
increase production

ORDINARY FIRE BRICK AFTER SERVICE

Depth of metamorphosed area is clearly shown by the color change. Observe how the original structure has been altered by penetration of aluminum and thermit reaction with iron oxide and silica brick.

TAYLOR ZIRCON AFTER SERVICE →

Section thru TAYLOR ZIRCON BRICK removed from hearth of aluminum re-melt furnace. 14,750,000 lbs. melted on this hearth. No penetration.



We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

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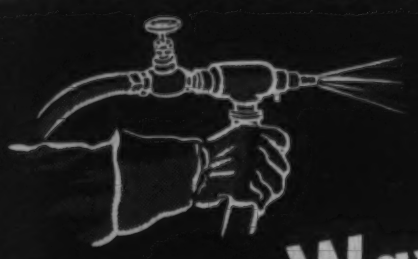

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2—*Light fire. Furnace is ready for immediate production.*

Heat of furnace vitrifies Brickseal permanently into all pores, cracks and joints, forming a highly-glazed, monolithic coating, impervious to acids, alkalis, corrosive gases, flame abrasion and air infiltration.

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oxide only. Full-scale tests would be necessary to test the smelting efficiency of such a furnace; an advantage would be that a cheap fuel of low physical strength would be able to support the reduced weight of the burden.

There seems to be no practical way of obtaining complete combustion of all the carbon, so that a mixture of carbon monoxide and carbon dioxide must be counted on. An increased proportion of the former means a higher fuel consumption in the furnace, but the flue gas would have a higher calorific value.

If a burden requiring 750 kg. (1660 lbs.) of coke to produce 1000 kg. (2200 lbs.) of iron in an ordinary blast furnace were used in a low-shaft furnace, the carbon required to produce 100 per cent of carbon monoxide in the flue gas would be about 1500 kg. (3320 lbs.) per ton of iron, and this would need 1200 cu. m. of oxygen, to which the ore would contribute about 300 cu. m. The blast would therefore have to supply about 900 cu. m. (317,000 cu. ft.) of oxygen per 1000 kg. (2200 lbs.) of iron, and this would increase the cost of the iron by about 10 R.M. (about $3.80, last official figure) per 1000 kg. (2200 lbs.).

—R. Durrer, P. Lwowycz & B. Marincek. *Arch. Eisenhüttenw.*, Vol. 16, Mar. 1943, pp. 329-332; abstracted in *Bull. Iron & Steel Inst.*, No. 92, Aug. 1943, pp. 104A-105A.

Permanente Makes Magnesium

Condensed from "Rock Products"

Production of magnesium from magnesite by the Hansgirg process in the plant of the Permanente Corp. in California is being watched with interest as a source of cheap magnesium. The basic idea of the process is to reduce magnesium oxide with carbon at a high temperature, dilute and cool the reaction products with a cold inert gas, and thus recover metallic magnesium.

The reversible reaction ($MgO + C = Mg + CO$) is forced to the right by the high temperature (2000 deg. C., 3630 deg. F.) of a three-phase electric arc furnace. Sudden chilling and dilution of the Mg-CO mixture minimizes the reaction between the two and gives a high yield of metal. The original process employed cold hydrogen introduced directly into the gas stream from the furnace. Approximately 50 volumes of hydrogen were used per volume of magnesium vapor.

The metallic magnesium is precipitated as dust containing some magnesium oxide and some carbon from the furnace. It is briquetted with oil, distilled at 750 to 950 deg. C. (1380 to 1740 deg. F.) in vacuo and the metal, condensed and collected as powder, is then melted and cast into ingots. The residue from the still ($MgO + C$) is returned. The mixture of hydrogen and carbon monoxide from the condensers is treated with steam in the presence of a catalyst to convert CO to CO_2, which is scrubbed out, and the hydrogen is returned.

This is substantially the process used at Radenthein, Austria. The magnesite used was as pure as was consistent with reasonable cost. The hydrogen must be low in carbon monoxide and free from carbon dioxide and water vapor. A large amount of hydrogen is required but once the process is started only enough is needed to make

For CLEAN STEEL and INCREASED PRODUCTION

- **Lunke-Rite**—an extremely effective exothermic, powdered compound for the control of piping in steel ingots poured *with or without*, hot tops; and in steel castings. It increases ingot yield considerably. The additional heat created has a beneficial effect on quality of steel by reducing rate of cooling in center section of ingot, which has been found to prevent internal cracks and laminations. This fact is especially important for large forging ingots.—Also used for fitting ladle stopper into nozzle;—as cover on steel in ladle where duplexing or reladling is practiced;—as cover on hot metal being transported a distance from blast furnaces;—etc.—LUNKE-RITE is available in grades to suit various needs. Information upon request.

- **Rite-Melt Cleanser**— containing no aluminum—placed on bottom of ladle or into stream or on bottom of mold.

- **Rite-Sulphur Reducer**—put in ladle.

- **Rite-Moldcote**— for steel ingot molds—can be easily sprayed and is economical to use.

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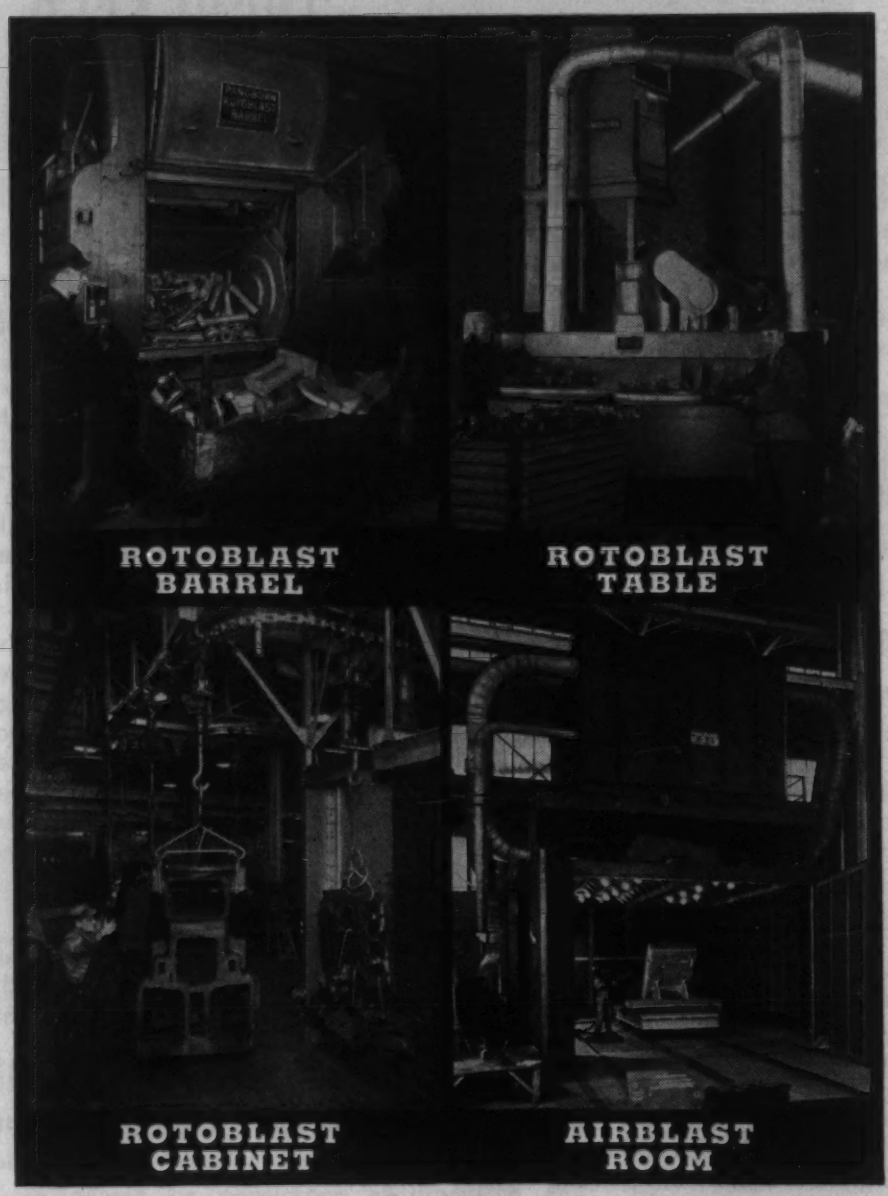

4 concerns—since January 1942—have invested a total of $1,036,830.50 in Pangborn blast cleaning and dust control equipment. As the engineering staffs in these organizations are second to none in thoroughness of investigation—and all items were purchased in competitive markets—the 7,673 square feet of Airblast ROOM area and the 31 ROTOBLAST units involved emphasize the CONFIDENCE these buyers have in Pangborn leadership.

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PANGBORN

WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION · HAGERSTOWN, MD.

up the mechanical losses. The electric furnaces used at Radenthein were 800-kilovolt-ampere capacity, three-phase arc furnaces.

At Permanente the first unit is a 9,000-kilovolt-ampere furnace. The ultimate capacity planned is 15,000 tons of magnesium per year. Condensation of the evolved magnesium vapor is to be effected by the use of large volumes of natural gas instead of hydrogen. After removal of magnesium and dust, the gas will be passed to the Permanente cement mill kilns for use as fuel. Past difficulties have been those to be expected from handling hydrogen and highly flammable magnesium in vapor and powder forms and are no more insurmountable than those in other electric furnace industries.

Data on the operation of the process at Radenthein give a power consumption of approximately 22,000 kilowatt-hours per ton of metal, a recovery of about 80 per cent of the magnesium fed as ore in the form of ingots of high purity, and a consumption of hydrogen of about 4 cu. ft. per lb. of metal produced. On this basis the cost should be low.

The present development is a joint venture of the Permanente Corp. and the Todd-California Shipbuilding Corp. The former is understood to control the Hansgirg process in this country. The latter is reported to be the responsible borrower of the major share of the funds required. About one-third of the R.F.C. financing of $9,250,000 was advanced for building the first unit and the balance was to be made available only after successful demonstration of the process in the unit.

—*Rock Products*, Vol. 46, Aug. 1943, pp. 110, 117.

Back Pull in Steel Wire Drawing

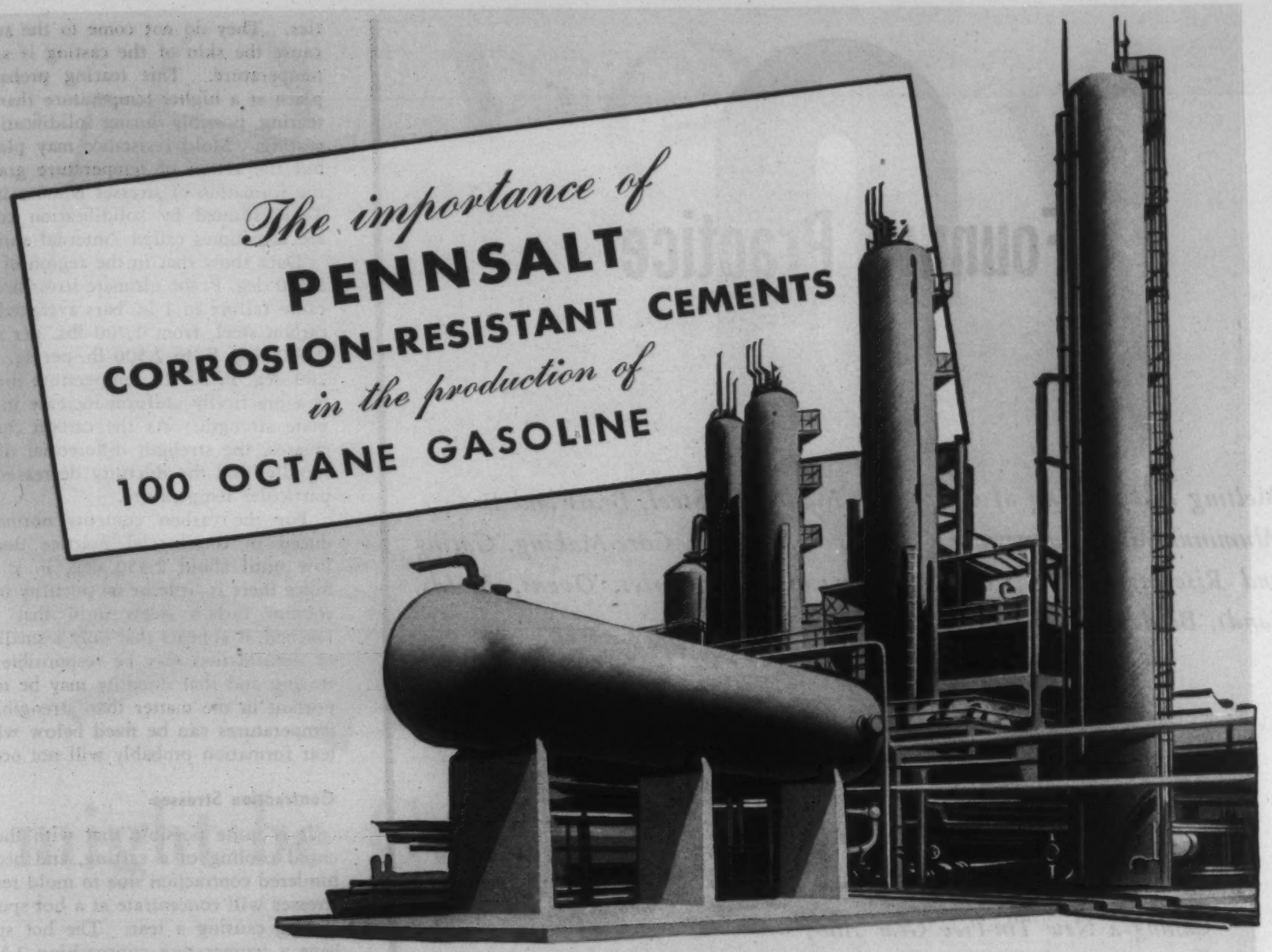
Condensed from "Stahl u. Eisen"

The authors report the results of tests in the drawing of patented steel wire (carbon 0.58 per cent) and a low carbon steel in which the back-pull technique was applied. The apparatus used enabled the forward pull, the back pull and the stress on the die to be measured.

The data obtained were in agreement with the calculated results. In all the tests there was a large increase in the forward pull as the stress on the die was decreased and a smaller decrease in the work of drawing required to recover completely the work done in the backward pull. The decrease in the die stress is considerable, and is at a maximum with the smallest reduction in diameter.

On the other hand, the rate of increase of forward pull is greater with increasing back pull at small reductions than at large reductions in diameter. The temperature at the surface of the wire as it leaves the die decreases with increasing back pull; there is also a slight decrease in the wire diameter with increasing back pull. The decrease in the load on the die caused by applying back pull results in increased die life and permits higher drawing speeds to be used.

—W. Lueg & A. Pomp. *Stahl u. Eisen*, Vol. 63, Mar. 25, 1943, pp. 229-236; abstracted in *Bull. Iron & Steel Inst.*, No. 92, Aug. 1943, pp. 115A-116A.



For the production of alkalates, blending agents and catalysts, required in manufacturing 100 Octane Gasoline, Pennsalt corrosion-resistant cements are used for the brick lining for concrete acid sumps (2-5% hot sulphuric acid) . . . repairs to hot acid plants producing charging stock . . . construction of tar drop-out pots . . . foundations and sewer system bonding material for muriatic acid generators producing HCl for use with isobutane . . . construction of carbon coolers and equipment for handling HF . . . sealing sulphuric acid drain lines and floors subjected to sulphuric acid in various concentrations . . . maintenance of apparatus to manufacture tetraethyl lead . . . apparatus for producing pentane-amylene fraction to produce aviation gasoline bleeding stock . . . with glass cloth to construct lining for aluminum chloride catalyst regenerators in presence of anhydrous hydrogen chloride, and gasoline vapors at a maximum of 350 degrees F. In addition, these cements are employed in the bonding apparatus used in the manufacture of anhydrous hydrogen fluoride, a catalyst used in this production, and in the construction of tanks producing HF acid.

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Penchlor Acid-Proof Cement can be supplied without restriction. Asplit and Causplit are available only for essential service.

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Hot Tears in Steel Castings

Condensed from "Foundry Trade Journal"

Hot tears are defects in the form of cracks, having an irregular and jagged appearance with the fracture face oxidized and showing a heat effect. Purchasers such as the U. S. Navy Dept. have radiographic standards for steel castings, illustrating examples of hot tears. Their presence is cause for rejection of parts subject to fatigue or impact stresses. Over 50 per cent of all steel foundries in the U. S. use either gamma-ray or X-ray radiography for the study of casting technique and for inspection. Magnetic testing is also used. It has been established that the hot tearing takes place at a temperature not greatly below the solidifying temperature of steel.

There are two types of hot tears—external and internal. In the former, the cracking begins at surface irregularities, sharp corners, etc. which serve as points of stress concentration. The latter are found near the centre of the section or where there is a pronounced hot spot or where solidification takes place last. They are more dangerous because hidden.

Hot tears are caused by stresses due to the design of the casting, the manner of casting and the construction of the mold. As steel cools it contracts, but hindered contraction, due to the resistance of the mold or the shape and form of the casting, increases the stress acting on the casting. In a design such as that of two bars joined by flanges, the temperature gradient produced within the casting sets up stresses greater than the elastic limit of the material. The stresses mount as the temperature falls and at the point at which the stress is greater than the properties of the steel, hot tearing occurs.

Causes of Tearing

Internal hot tears are caused by the same conditions as external ones, and by solidification contraction, which, because of insufficient feed metal may cause hot tears in a section instead of the usual shrinkage cavities. They do not come to the surface because the skin of the casting is at a lower temperature. This tearing probably takes place at a higher temperature than external tearing, possibly during solidification of the casting. Mold resistance may play a part, but the action of temperature gradients in the formation of stresses is more important. Tears formed by solidification contraction are sometimes called "internal shrinkage."

Data show that in the region of 2,300 to 2,400 deg. F. the ultimate stress necessary to cause failure in 1 in. bars averaged, for cast carbon steel, from 1,700 lbs. per sq. in. at 2,370 deg. F. to 2,500 lb. per sq. in. at 2,280 deg. F. As the temperature drops there is a practically uniform increase in the ultimate strength. As the carbon content increases, the strength differential diminishes rapidly, and the ductility decreases for any particular temperature.

For the carbon contents normally produced in commercial practice ductility is low until about 2,350 deg. F. is reached. Since there is little or no ductility in normal content carbon steels until that point is reached, it appears that only a small amount of deformation may be responsible for hot tearing and that ductility may be more important in the matter than strength. If so, temperatures can be fixed below which hot tear formation probably will not occur.

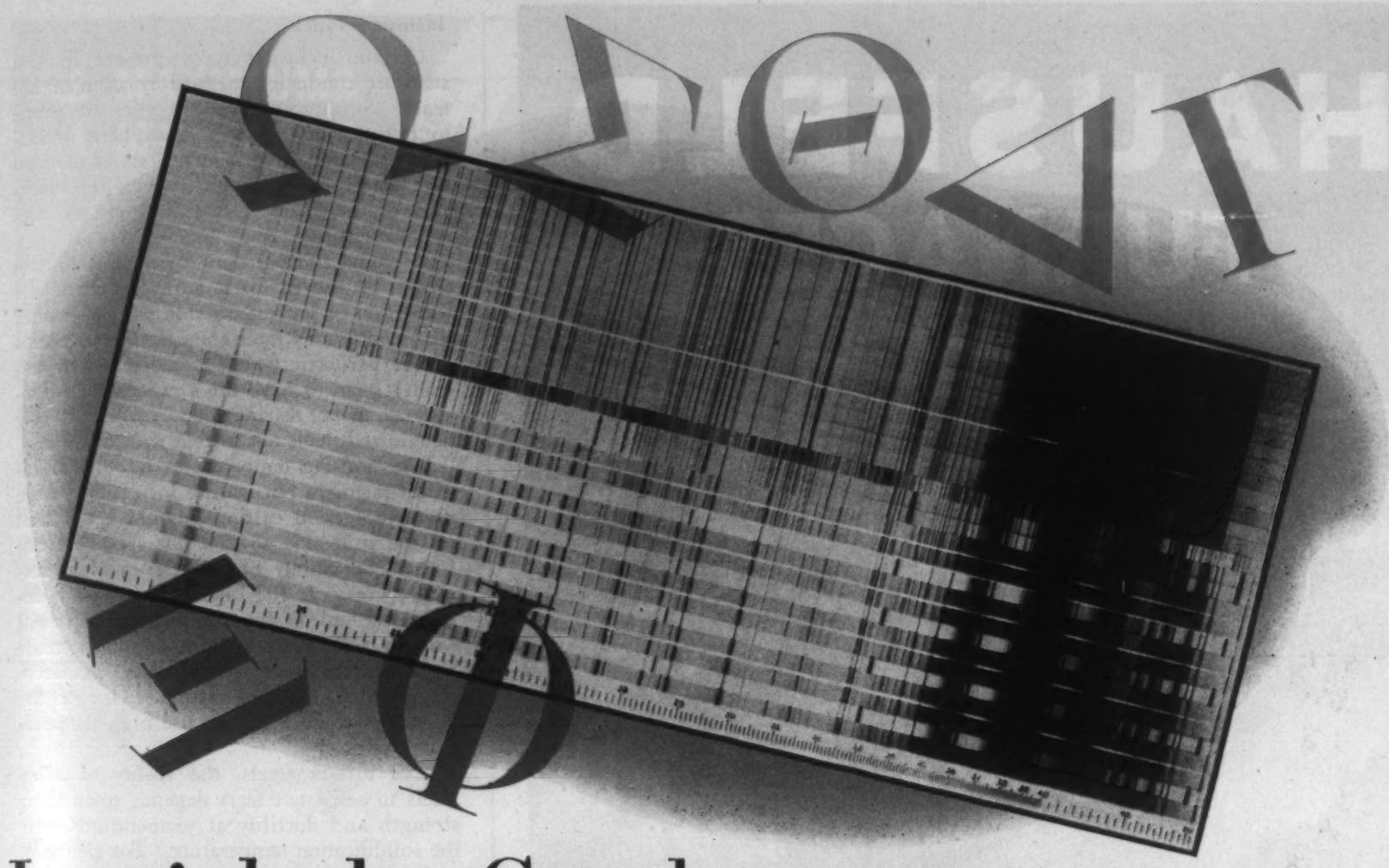
Contraction Stresses

It is quite possible that with the differential cooling of a casting, and because of hindered contraction due to mold resistance, stresses will concentrate at a hot spot in the casting causing a tear. The hot spot may have a temperature approaching 2,500 deg. F. while other parts will be at temperatures of 2,250 to 2,300 deg. Stresses of 250 to 500 lbs. could then arise through hindered contraction, which if concentrated on the hot spot are sufficient to cause tearing.

It can be demonstrated that sands and cores can provide, at elevated temperatures, sufficient hindered contraction to cause tears. While the sand at the mold-metal interface is at a temperature of about 2,500 deg. F. with a strength of perhaps 20 lb. per sq. in., the sand only ⅛ in. away would be at about 2,000 to 2,200 deg. with a possible strength of 1,000 lb. per sq. in. Sand of such high strengths tends to prevent normal contraction of the casting. For steel castings the maximum hot strength at 2,500 deg. F. for sands should not be over 25 lbs. per sq. in.

High and low carbon steels should not be compared as to susceptibility to hot tearing. Which steel to use will depend on the mold conditions and the casting design. It is suggested, however, that low-carbon steels be used first, if excessive hot tearing is encountered, because they have 1.4 times the tensile strength and 8 times the ductility values of high-carbon steel at 2,300 deg. F.

In discussing the basic vs. the acid process, it has been shown that as the sulphur content increases, the strength and ductility of cast steel at high temperatures falls off extensively. By the use of the basic practice it is possible to keep the sulphur content low, preferably below 0.025 per cent from the standpoint of hot tear susceptibility.



It might be Greek to you —

Yes, the Spectrogram above might very well be Greek to you. But it is a highly indispensable and invaluable part of the system of controls used by Michigan Smelting technicians in developing non-ferrous alloys to precision specifications. The spectro lines identify the various elements contained in the alloy. By rapid mathematical evaluation of the spectro lines, our metallurgists are able to accurately determine the composition of each heat while it is still in the furnace. The speed of this method enables them to control the composition of the molten metal to meet exacting specifications before the casting of the ingots.

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Inclusion Types

Certain inclusion types present in cast steel are conducive to the formation of hot tears. Silicate and eutectic types are prone to hot tearing because atmospheric oxidation produces eutectic inclusions at the surface of the casting, which lowers the resistance of the steel. The galaxy type of steel is less sensitive.

Alumina and peritectic types are more resistant at the oxidized surface due to the formation of separated oxide particles rather than continuous inter-granular films. Steels of the peritectic type (deoxidized with calcium) seem to have the same degree of resistance to hot-tearing found in the strongly deoxidized steels not treated with calcium.

The pouring temperatures is only an indirect factor in hot tearing formation. Large uniform section castings should be poured on the cold side so that hot spots are not formed by unduly heating the mold in certain places. If the casting is properly desinged to allow for controlled directional solidification, every attempt should be made to establish large temperature gradients within the mold and casting. One of the best ways to do this is to use high temperature steel.

Like carbon steels, the ability of alloy steels to resist hot tears depends upon their strength and ductility at temperatures near the solidification temperature. For example, nickel-chromium cast steels are very susceptible as they are lower in strength and ductility than plain carbon steel and the hot tear temperature range is longer.

The best method of preventing hot tears is to keep hindered contraction stresses to low values by using relieving blocks or friable material in the backing sand or low strength sand for the cores. Castings should be so designed that they will not be closed stress-active systems wherein temperature gradients may be responsible for large stresses. Every section should be well fed. The steel should be of low inclusion content and of proper inclusion type. Proper chills should be applied to prevent hot spot formation. Ribs or cracking strips should be used to assist in preventing stress concentration and the pouring temperature should be consistent with the design.

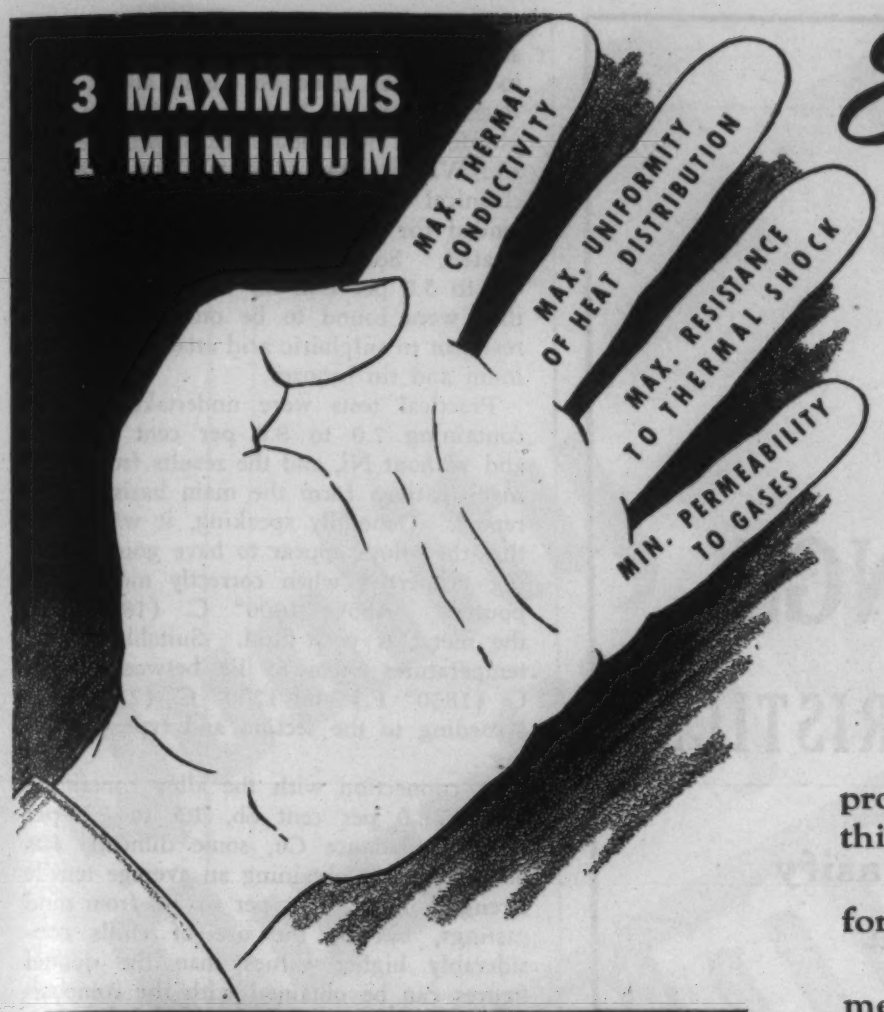
—Charles W. Briggs, *Foundry Trade J.*, Vol. 70, Aug. 5, 1943, pp. 277-282; Aug. 12, Vol. 70, pp. 303-308.

Casting a New Tin-Free Gear Alloy

Condensed from "Foundry Trade Journal"

This report was submitted to the 40th annual conference of the Institute of British Foundrymen. Up to 1940 the equilibrium diagram of the Cu-Sb system showed that Cu is capable of holding approximately 9 per cent Sb in alpha solid solution at temperatures below 650° C. (1200° F.). In the light of more recent research conducted in Japan by Shibata it has been suggested that the solubility of Sb in the alpha phase decreases gradually from 10.4 per cent at 645° C. (1190° F.) to 7.6 per cent at 488° C. (910° F.), to 6.2 per cent at 400° C. (750° F.) and to 4.7 per cent at room temperature. All these experiments were conducted on specimens practically free from oxide.

In 1941 the Japanese gave attention to



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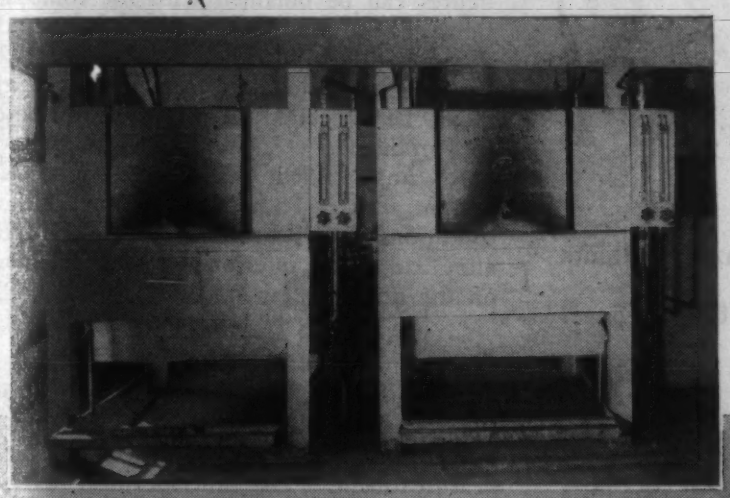
Non-Gro silicon carbide muffles are specified for temperatures up to 1800° F. They provide adequate protection against oxidation in this critical range.

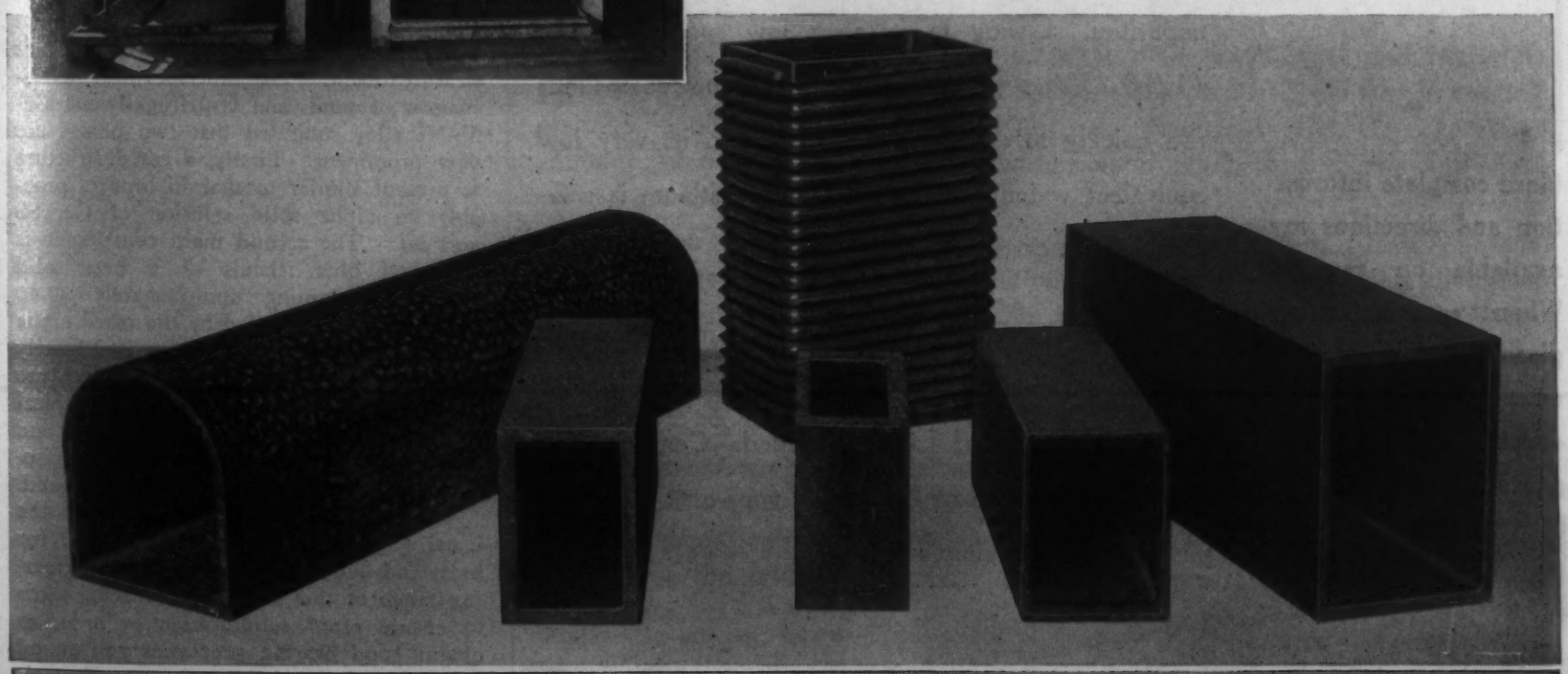
Kellogg AA silicon carbide muffles are specified for temperatures above 1800° F.

Kellundite fused alumina muffles are recommended when corrosive slag or scale are present. (Often a slab of Kellundite is used in a muffle to serve as a false floor as a protection against such slag conditions).

The economy of Electro's muffles for all types of annealing and heat treating furnaces — oil, gas and electric, is created by high thermal conductivity, high resistance to thermal shock (do not crack easily) and uniform heat distribution.



Furnaces constructed by Surface Combustion Corp. equipped with Electro's refractories.



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the Cu-Sb-Ni system. Apart from the above the only other work which appears to have been done on Cu-Sb alloys is an investigation of their resistance to sulphuric acid published in Russian by Pershke and Vasyutovich. In this research the chemical stability of antimony bronzes intended for replacing tin-bronze was investigated. Solid solution alloys containing 4.0 to 5.0 per cent Sb were prepared and they were found to be only slightly less resistant to sulphuric acid attack than aluminum and tin bronzes.

Practical tests were undertaken on Cu containing 7.0 to 8.0 per cent Sb with and without Ni, and the results from these investigations form the main basis of this report. Generally speaking, it was found that the alloys appear to have good founding properties when correctly melted and poured. Above 1000° C. (1830° F.) the metal is very fluid. Suitable casting temperatures seem to lie between 1000° C. (1830° F.) and 1200° C. (2190° F.) according to the section and type of casting.

In connection with the alloy containing 7.0 to 8.0 per cent Sb, 1.5 to 2.5 per cent Ni, balance Cu, some difficulty has been found in obtaining an average tensile strength of 14.2 tons per sq. in. from sand castings, but by the use of chills considerably higher values than the quoted figures can be obtained with the composition specified and when modified by the addition of 0.5 to 1.0 per cent Zn. Accordingly the use of chills or centrifugal casting might be suggested as preferable methods for production. Chilling does not effect much improvement when there is no Ni present, and in both sand cast and chilled conditions the properties of the Ni-free alloy are much inferior to those obtained on the nickel-containing alloy.

Bearing Metal Attributes

An interesting point brought to light is the fact that the Cu-Sb-Ni alloy can be hardened appreciably by low-temperature heat-treatment. The microscopical examination of sand- and centrifugally-cast Cu-Sb-Ni alloy indicated that two phases are very prominent. Firstly, a cored structure is present similar to that in bronze, probably an alpha solid solution of Cu, Sb and Ni. The second main constituent is dispersed blue islands of a beta solid solution containing approximately 30-40 per cent Sb, surrounded by the cored alpha solid solution. The beta phase is definitely the hard bearing constituent. There are therefore all the attributes of a typical bearing alloy present, a fairly soft and yielding matrix included in which are isolated particles of a hard bearing compound.

The etching medium employed was the usual ferric chloride solution as used for brass and gunmetal. Due to the long freezing range of this alloy, care must be taken to ensure rapid solidification in order to obtain good bearing properties and sound castings. Cu and Ni are mutually soluble. Each can dissolve about 8 to 9 per cent of Sb, and with high Sb content each can form a beta phase.

Alloys containing less than 30 to 45 per cent Sb will form (at high temperatures) only two phases, alpha and beta. Both beta phases undergo transitions at

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lower temperatures. An alloy containing 7½ per cent Sb and 2 per cent Ni would, on equilibrium, be entirely alpha, but with normal rates of cooling should consist of heavily cored alpha with a certain amount of beta, which may be partially changed to epsilon during subsequent cooling. The liquidus of the alloy is approximately 1020° C. (1870° F.), the solidus approximately 650° C. (1200° F.). The report concludes with an appendix giving suggested methods for analyzing this type of alloys. Report is illustrated with the equilibrium diagrams and micrographs.

—*Foundry Trade J.*, Vol. 70, July 1, 1943, pp. 177-181, 193; July 8, pp. 191-195, 203; July 15, pp. 213-218.

Preventing Oxidation in Magnesium Melting

Condensed from "Light Metals"

According to Pilling and Bedworth the protective character of an oxide is a function of the relative density of the oxide and the metal taking part in the reaction as expressed in terms of specific volume. If the "protection coefficient" is under 1, the oxide is not protective.

In the case of magnesium, Delavault confirmed this theory, on the basis of the following equations, even when films other than oxide were considered:

	Protection Coefficient
$Mg + O = MgO$	0.71
$Mg + CO_2 = MgO + CO$	0.71
$3\ Mg + N_2 = Mg_3N_2$	0.79
$2\ Mg + CO_2 = 2\ MgO + C$	0.90
$3\ Mg + SO_2 = MgS + 2\ MgO$	0.92
$Mg + CO = MgO + C$	1.08
$Mg + S = MgS$	1.26
$3\ Mg + 2\ BF_3 = 3\ MgF_2 + 2\ B$	1.32
$Mg + 2\ HF = MgF_2 + H_2$	1.32
$3\ MgO + 2\ BF_3 = B_2O_3 + 3\ MgF_2$	3.1

Much foundry experience can be explained by means of these equations.

Elemental sulphur is added to molding sand and used as a dusting powder, while SO_2 is used to displace air from molds prior to pouring. Although burning magnesium continues to burn in SO_2, the gas certainly does prevent excessive oxidation of the molten metal at high degrees of superheat. Therefore, in accordance with the equations, a great excess of sulphur protects molten magnesium. When sulphur is thrown on molten magnesium, the burning does not commence until long after the fused sulphur has formed SO_2. This agrees with the equations which show that SO_2 gives a lower coefficient than sulphur. In other words, excessive oxidation will be prevented as long as elemental sulphur is present.

Nitrogen gives about the same coefficient as oxygen, which explains the failure of experiments to substitute nitrogen for sulphur in the magnesium foundry. CO_2 should be somewhat more efficient and is.

Delavault's work confirms the wisdom of the choice of sulphur + boric acid and ammonium bifluoride for inhibitors in molding sands. In England finely divided sulphur is used to prevent the oxidation of the metal during the passage from the pouring pot to the mold; in the U.S., a mixture of sulphur plus boric acid plus ammonium borofluoride has been found to be much

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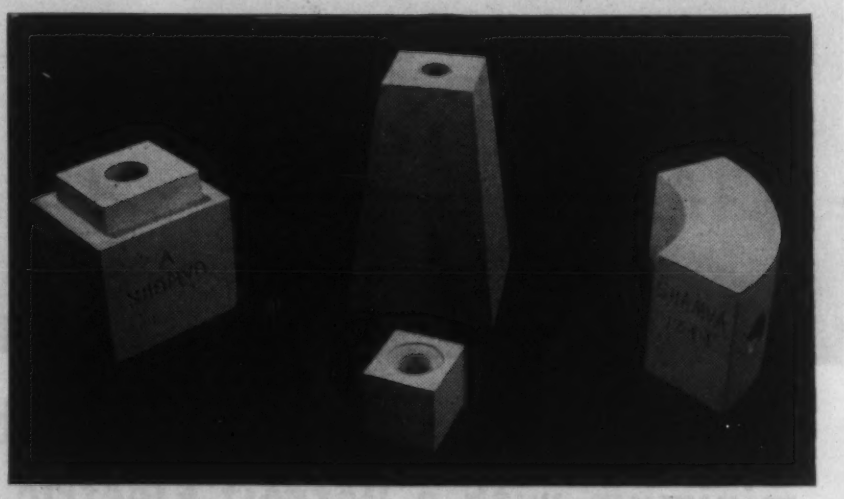

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- Resistance to slag and abrasion.

better than sulphur especially over 800 deg. C. (1470 deg. F.). This practical experience is confirmed by the high protective coefficients of the fluorides.

—*Light Metals*, Vol. 6, Sept. 1943, pp. 418-420; based in part on a thesis by R. Delavault.

Making High Test Iron

Condensed from "Canadian Metals & Met. Industries"

The use of a cupola as the means of melting prohibits the charging of more than 70 per cent of steel in the mix. When running a high test heat, the height of the coke bed is increased by approximately 20 per cent. High test iron must be poured hot. Charges are made up of steel, No. 1 pig, and scrap, charged in that order, and when more than one charge is being melted, the amount of coke between the charges is increased. Ferrosilicon and ferromanganese briquets are charged and SMZ alloy and scrap copper are used as graphitizers at the spout.

If the casting has very thin sections calling for machining, nickel is a better graphitizing agent than copper. Further spout additions are chromium for exceptional hardness and molybdenum for toughness. Molding practice must follow steel shop practice and molds should be dry. If any disturbance takes place in a mold, due to wet facing sand or steam, high test iron will not recover itself.

Larger castings are either bedded in the floor and dried with charcoal, or rammed up in boxes and dried in the oven. Wherever possible, smaller patterns are split and matched in core boxes. After drying, these pairs of matched cores were pasted up ready for casting.

Gating and risering play an important part in this type of practice. In general jobbing work, side risers cut in the shape of "W" and as large as the job will permit, make the best type of riser for high test practice. The header from these risers should never be less than 4″ in diameter. Where possible, down-gates are placed about 8″ or 9″ from one of these side risers and in-gates are cut, not into the castings, but into the riser. If the in-gate is cut into the castings, one is likely to find a small shrink hole when the gate is knocked off. When the top risers must be used they are made as large as possible and a feeding rod is never used on the high test casting.

Special care must be taken to see that the facing sand and blacking are as nearly perfect as it is possible to get them. Wherever possible, the cores are made of black sand, but if an oil-sand core is needed it is made with a mixture of sharp sand, oil and a large percentage of a good grade of fire clay. All cores are blackened twice with a good grade of carbon blacking. The mold must be bone dry.

High test iron is doing a very good jou in the field of gear blanks. Cemented carbide cutters of various shapes are welded or brazed into pieces of high test iron which serve the purpose as well as the steel stock previously used.

—W. J. Brill, *Can. Metals & Met. Inds.*, Vol. 6, Aug. 1943, pp. 25-26.

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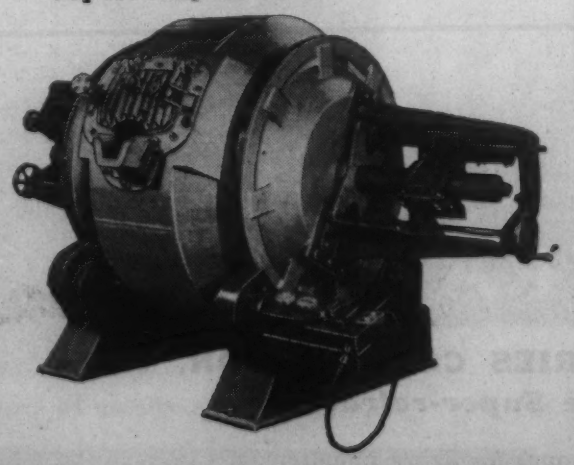

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Portable Aluminum Furnace

Condensed from "Industrial Heating"

A 1000-lb. capacity portable melting furnace and ladle combination at General Electric's Schenectady Works permits a direct pour from furnace to mold, obviating the need for superheating the aluminum alloy charge, and for preheating transfer ladles. The furnace-ladle is oil-fired, trunnion-mounted in a wheeled frame, with eye plates for lifting the entire assembly by a crane.

The oil burner is removable, and fits against the furnace wall at a tangent so that the flame is spiralled downward into the charge. Oil is fed through a flexible metal hose, and air through a rubber hose.

The best pouring temperature for the ½-in.-thick casting is from 1290 to 1310 deg. F. This would ordinarily require heating the charge to as much as 1475 deg. F. but with the furnace-ladle it is necessary to go to only 1380 deg. F. No cold shuts were experienced on any of the castings. The firebrick lining has been replaced only twice in handling more than 2500 charges.

About one-third of the castings were made with a 5 per cent Si alloy. An alloy of 4 per cent Cu, 2½ Si, balance aluminum was later used.

The combination weighs about 3 tons, charged.

—*Industrial Heating*, Vol. 10, August 1943, pp. 1144-1146.

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Cooling Rates of Arc Welds

Condensed from an American Welding Society Paper

Actual cooling rates in the heat-affected zone adjacent to arc welds have been measured at points close to the fusion line. Simultaneous measurements of arc power, voltage, current, and travel speed have also been made to permit the reproduction of these cooling curves. Cooling rate data have been obtained in ship steel, ASTM A131-39, for the welding of the last pass of butt welds in ¼, ⅜, ½, ⅝, ¾, ⅞, 1, and 1½ inches, and for plate temperatures of 37, 72, 210 and 400 deg. F.

Mathematical solutions for cooling rates have been modified by experimental measurements, to permit a wide extension of the data. These data are tabulated for nine different plate temperatures between 37 and 400 deg. F. Cooling rate data are tabulated for temperature levels between 700 and 1300 deg. F. at 100 degree intervals. The data for 1 in. and 1½ in. plate are sufficiently close to permit interpolation for intermediate thicknesses. For this thickness range the plates are cooling practically as plates of infinite thickness so that very little difference is noted.

For plate thicknesses greater than 1½ in., the similarity in cooling curves is even more complete, and the data for 1½ in. plate may be used. The work completed for the War Metallurgy Committee of the National Research Council — National Academy of Sciences included data for ½, 1, and 1½ in. plate. It was noted at that time that further work was necessary in order to provide interpolation for plate thicknesses between ½ and 1 in. This was due to the fact that a wide difference in cooling curves exists in this thickness range, owing to the transition from thin plate to thick plate behavior.

Funds provided by the Welding Research Council of Engineering Foundation permitted the continuation of the original work, including the thicknesses ¼, ⅜, ⅝, ¾ and ⅞ in. In the original work, a great many actual welds were made using single vee butt welds for ½ in. plate, double vee welds for 1 in. and 1½ in. plates. For 60 deg. bevel welds planned in the earlier work by the committee do not permit the attainment of good fusion at the root of the weld without a great deal of chipping.

It was found experimentally that a plate could be grooved approximately 3/32 in. deep and of the appropriate width for the plate preparation planned, and that a single pass could be deposited in this groove to simulate the last pass of butt welds. By this technique a great reduction in the time required to cover the large number of different energy inputs and plate temperatures and plate thicknesses was made, permitting a great increase in the original data by the introduction of the plate thicknesses mentioned above.

Weld Cooling Rates

Although cooling rates have been determined for welding conditions in ship steel, ASTM A131-39, it has been found that these rates will be reproduced in SAE 1035, NAX 9115 and NE 8620. From this it appears that such differences in thermal properties as do exist between these steels have only a minor effect on the cooling curves.

It has been found that from the standpoint of determining cooling rate, it is convenient to group arc travel speed, arc voltage and arc current in amperes into a single factor, energy input per unit length of weld in joules per inch. In view of the facts just mentioned, the only factors which may be considered as affecting weld cooling rates in a wide variety of plain carbon and low alloy steels are energy input in joules per inch, plate thickness, plate temperature and joint geometry.

The size of electrode used with a given energy input has an effect on weld cooling rates, the larger electrode producing lower cooling rates. First pass cooling rates in butt welds have been found to be considerably lower than top pass cooling rates. This points to the need for further study of the first pass cracking problem. The general experience that cracking may be troublesome in deposit-

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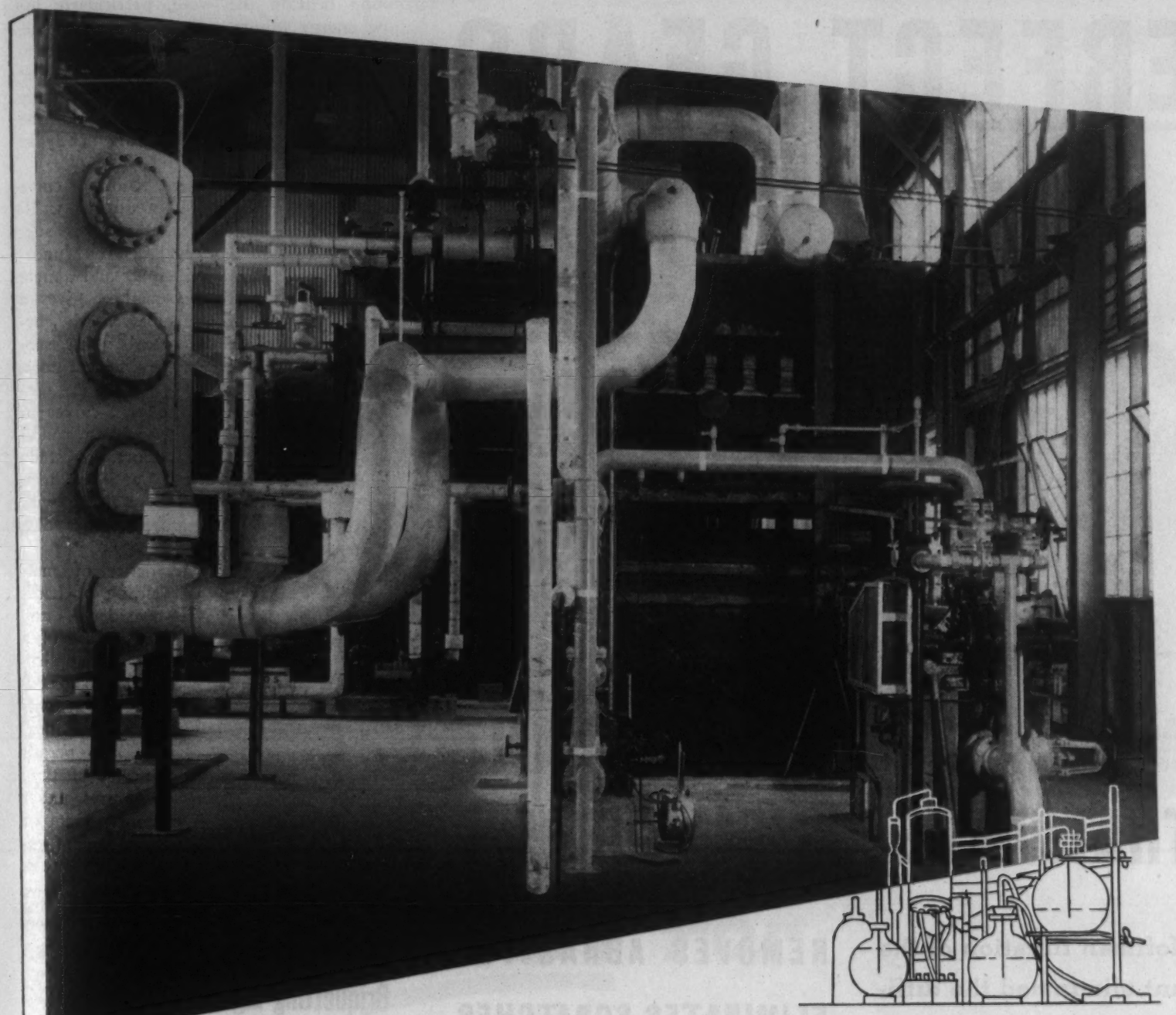

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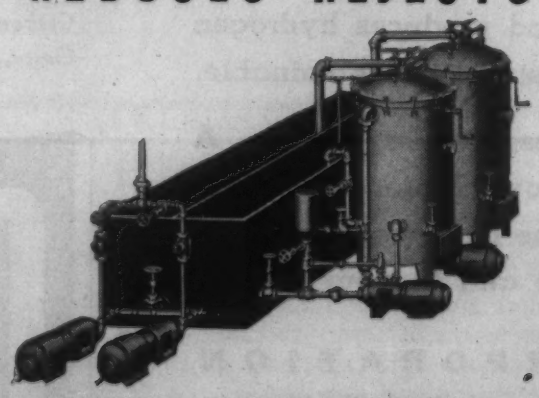

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ing the first pass must be due to other factors than cooling rate in the zone adjacent to the weld.

In ½ in. plate, much higher cooling rates are found near the surface of the plate at the edge of the weld than are found beneath the weld, particularly for low energy inputs. This behavior is due to the fact that a ½ in. plate in comparison with thicker plates, cools more nearly as a thin plate heated uniformly throughout its thickness, than do the heavier plates which cool more nearly as infinite solids.

A method of applying cooling curve data to the problem of predicting welding conditions for different steel is suggested. This method is based on fundamental metallurgical principles and simple tests. The use of this method gives a clear insight into the factors which govern the behavior of a steel when subjected to the thermal cycle incident to a welding operation.

A discussion of the use of S-curves in the prediction of proper welding conditions is included in the report. A study of the tempering effects at low temperatures which result from welding with a plate preheat temperature at 400 deg. F. is also presented.

The possibility of avoidance of martensitic cracking in the welding of hardenable steels has been considered, and data are presented to enable the use of a special technique involving the application of the tempering effect of succeeding passes following each other at sufficiently close intervals. Mathematical equations have been developed to permit the determination of the amount of time available between successive passes under a variety of welding conditions. Data of this kind should make possible a more extensive use of arc welding for alloy steels.

—W. F. Hess, L. L. Merrill, E. F. Nippes, Jr. & A. P. Bunk. Paper, Am. Welding Soc., October 1943 meeting.

Briquetting Light Metal Turnings

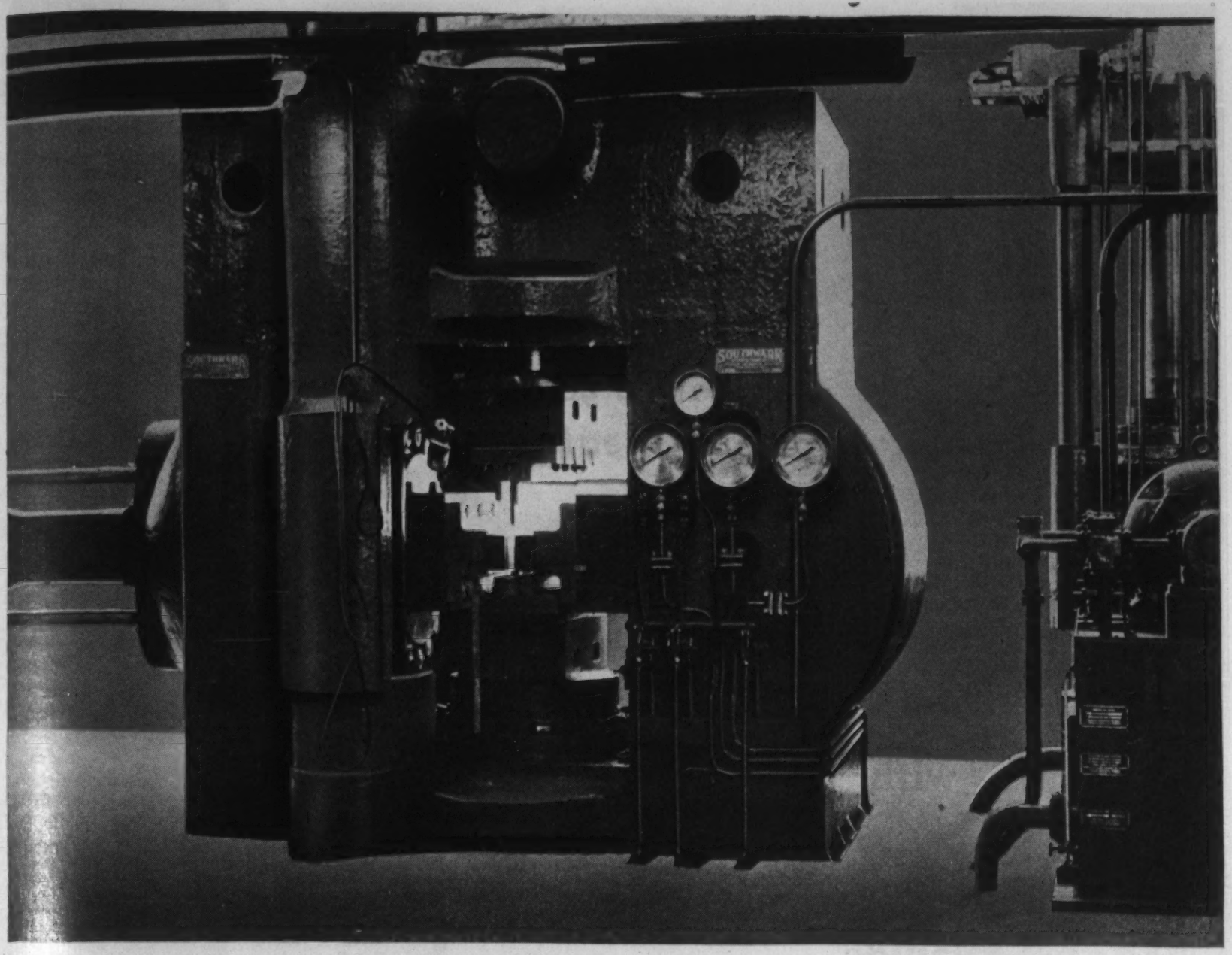
Condensed from "The Iron Age"

A method of mechanical ingoting has recently been devised and a quantity of ingots made in a pilot plant. Ingots can be used for melting the same as cast ingots; they can also be used for deoxidation and alloying. Complete evaporation of water and oil, and precise temperature control during the ingoting process, eliminate oxidation and contamination. Ingots are also suitable for extrusion and forging.

If borings, turnings, chips, etc., are segregated, large uniform lots of ingots can be turned out. Exposure of large surfaces to the action of heating gas and air is detrimental to quality. Influence of oxides and gas and loss of alloying elements change the original quality of most of the scrap.

It is found that only by hot compressing with temperature below melting point, combined with preliminary deoiling and drying, could the surfaces be completely reduced to a minimum. (Patent nos. 2,299,043; 2,302,980; British 540,105; Canadian 477,027).

Oily and wet turnings, etc. are discharged into a pit. The bushy part is



It's U.D. for POWDERED METAL

Here is a powdered metal press especially constructed by Southwark for the purpose of insuring the U. D. (uniform density) of a compressed object. This is accomplished by compelling the upper and lower rams — each of 3000 tons capacity—to oppose one another and allow the powdered metal to be compressed from both the upper and lower dies.

Just another example of Special Machinery designed and constructed by Southwark engineers.

Baldwin Southwark Division, The Baldwin Locomotive Works, Philadelphia, Pa.; Pacific Coast Representative, The Pelton Water Wheel Co., San Francisco, Calif.

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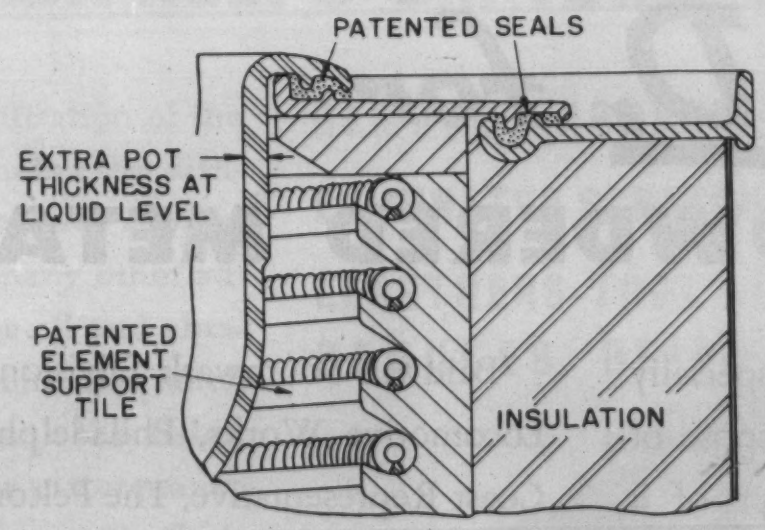
at several before you buy but be sure you get these features:

Check List:

- Easily operated insulated top cover
- Double flange pot
- Double flange supporting ring
- Double flange top ring
- Extra pot thickness at liquid level
- Element — one continuous helix extra heavy rod
- Positive element support in recessed refractory wall
- Lining 12¾ inches
- Two point heat control
- Time clock starting



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screened out by a vibrating screen and crushed. Material is conveyed to a rotary dryer, where the drying time is about 10 min. Next it passes through a magnetic separator, then through two other dryers.

From there turnings pass to a hopper, connected to a press and condensed to about 50 to 60 per cent density. The filled die is placed in a pusher type furnace and heated to 500-850 deg. F. The heated metal is then pressed to an ingot of practically 100 per cent density.

—Max Stern, *Iron Age*, Vol. 152, Aug. 12, 1943, pp. 90-92.

Nitriding Tools in Liquid Salt Baths

Condensed from "Steel"

The objectionable feature of earlier salt bath mixtures, the formation of carbides, was at a definite ratio with the depreciation of the cyanide. It was definitely proven that any formation of carbon produced a soft skin.

As an example, a modern salt bath for nitriding has a melting point of 920 deg. F. with an operating range of 1000 to 1200 deg. F. It is a cyanide-base bath, to which other materials are added to control the rate of cyanide decomposition, and rate of nitride absorption, and to inhibit absorption of carbon or carbides.

Addition of fresh salts to replace drag-out losses will usually maintain bath efficiency. If there is little drag-out loss, the bath can be bailed out periodically by 5 to 10 per cent and replacement made with fresh salts.

The usual temperature is either at, or slightly below, final tempering temperature, generally 1025 to 1050 deg. F. Fragile tools are treated at 950 to 1000 deg. F. Time of treatment varies from 10 to 90 min.

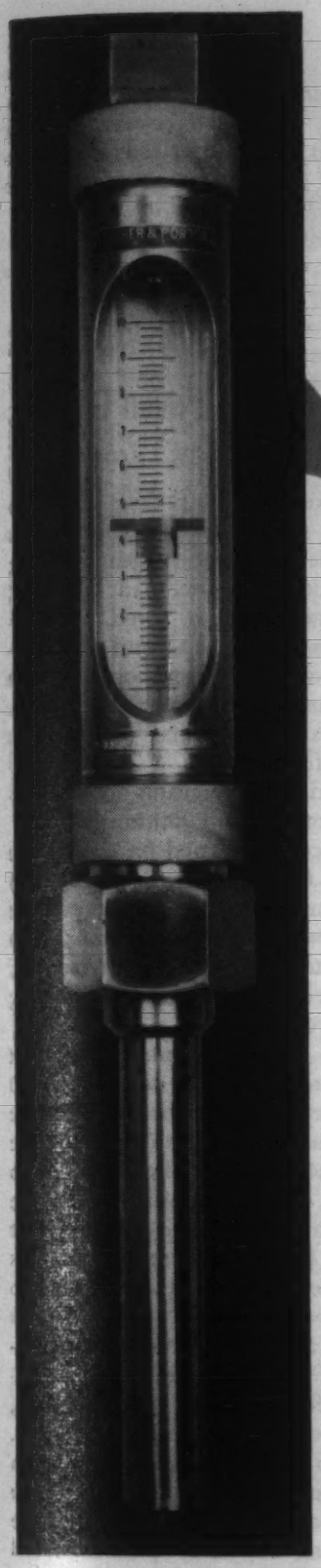
Tools subject to shock, as those used on ferrous materials, are treated for shorter periods, whereas longer treatment is of advantage for those intended for non-ferrous metals and plastics.

Usual depth of nitride penetration is from 0.001 to 0.002 in. for treatments of 30 to 90 min., and below 0.001 in. for treatments of 10 to 20 min. A superficial case can be measured only by a scratch test or Vickers hardness reading.

At 1050 deg. F., 30 min. immersion, a penetration of 0.0013 in. averaged 937 Brinell; at 60 min., penetration of 0.0017 in. averaged 1026 Brinell; at 90 min., penetration of 0.0019 in. averaged 1065 Brinell. These readings were determined by the Vickers instrument and transposed to Brinell.

Nitriding does not increase the size of the tool, when tempering has been completely effected. Tests have determined that variations in size between proper tempering and nitriding in the liquid salt fall within 0.0001 in. Any greater variation would not be due to nitriding, but is caused by undue transformation of austenite to martensite, which is induced by improper heat treatment and draw prior to nitriding.

Ideal condition for high-speed steel, after hardening, is the austenitic state in which most of the tungsten and chromium carbides are absorbed in solid solution. This austenitic state is then drawn at 1050



The Furnace Flow Guide with built-in dashpot for handling pulsating gas or liquid flows.

The HEART of the

FURNACE FLOW GUIDE

is this precision-bore transparent metering tube!

A metal tube or an orifice plate flow meter may soon read inaccurately because of (1) corrosion and (2) dirt. It, then, becomes the *unsuspected* reason for faulty annealing or carburizing results. These two enemies of accurate gas flow measurement, dirt and corrosion, cannot affect the Fischer & Porter "Flow Guide." Its precision-bore metering tube is as accurate as a rifle barrel when first made, and *it remains that way forever.*

Why? Well, first the tapered metering tube is made of heavy-walled, boro-silicate glass, processed by our exclusive low temperature "Glo-Tech" method. The finished tube is *highly* resistant to corrosion from all gases and chemicals. Its true roundness and precision taper never change.

Second, the metering tube is transparent, so that dirt can be seen the very minute it starts collecting. In a few seconds you can remove the bottom extension of the "Flow Guide" and clean the meter thoroughly. The meter is then as accurate as the day it was installed.

If you wish to operate your inert gas generators and furnaces with flow meters *that you can believe,* try the Furnace Flow Guide. Its high accuracy is fully protected against dirt and corrosion. For the complete, interesting details, write for bulletin 30-C—sent without any obligation.

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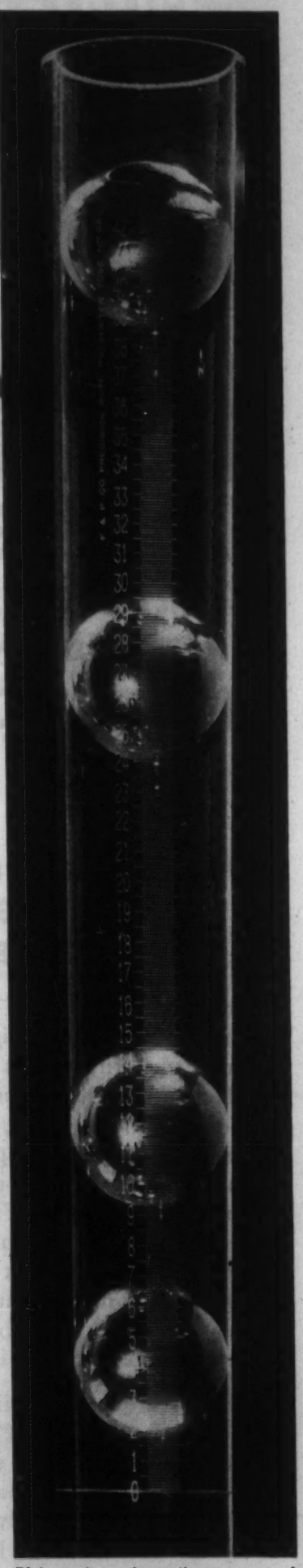
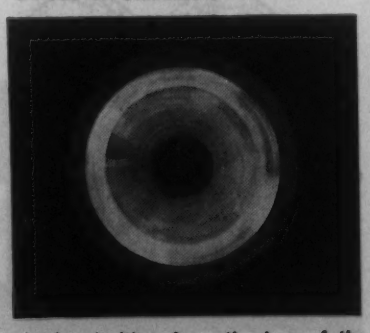
You will be able to see our latest developments at BOOTH 304-306—CHEM. SHOW, NEW YORK—DEC. 6 to 11.



Picture above shows the accuracy of the taper being checked with steel balls standardized by the U. S. Bureau of Standards.



A view looking down the bore of the metering tube of the Furnace Flow Guide—notice that it is smooth as a gun barrel.

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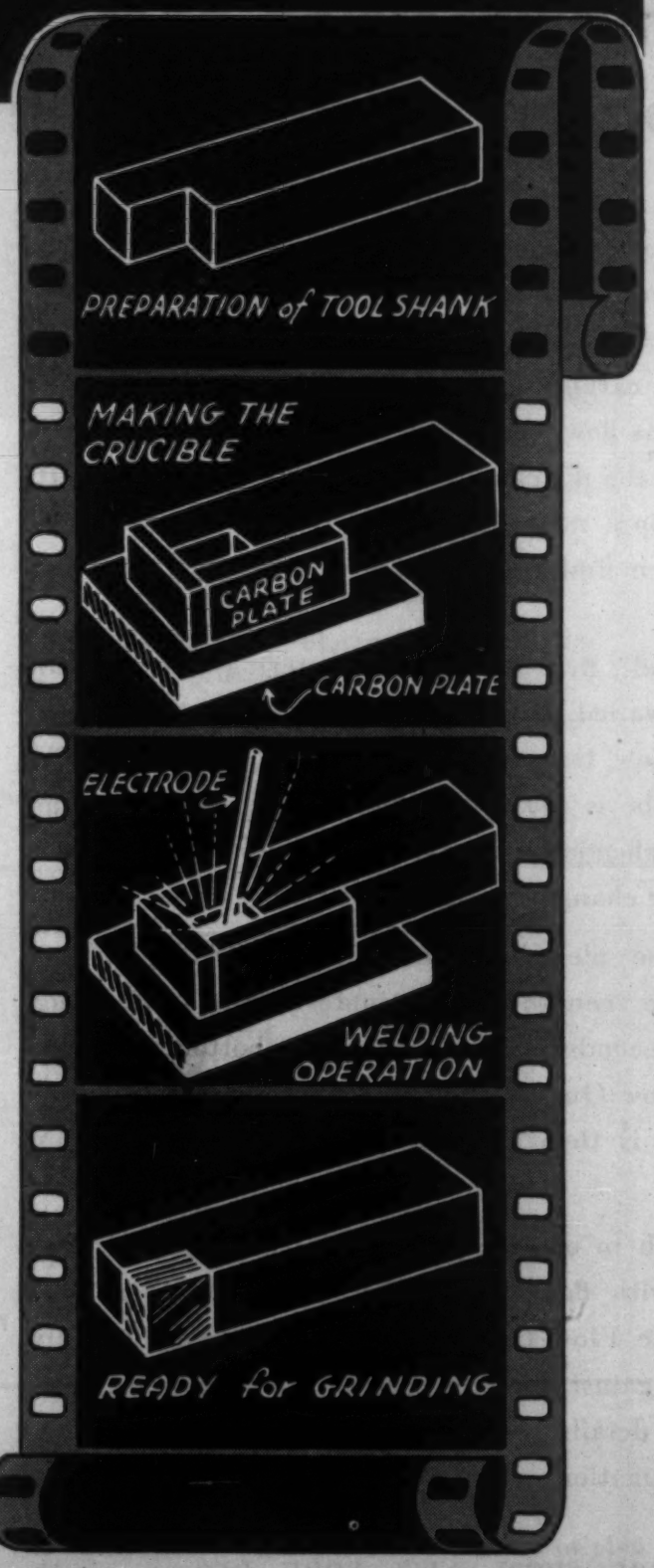

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are specially designed for the building-up of high-grade cutting edges of all kinds. The illustrations at right show, in sequence, the proper method of forming a cutting tool edge. This Crucible-Arc method gives a weld deposit of *dense* hard metal that is easy to make and absolutely free of porosity.

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to 1150 deg. F. so that it slightly approaches martensitic.

Tools must be heat treated before nitriding, with no carburized or decarburized layers. Of the two, a slightly decarburized layer is preferable.

Salt bath nitriding has increased tool life, in many cases, by 200 to 300 per cent. The cost is very low.

—G. W. Esau, *Steel*, Vol. 113, July 12, 1943, pp. 104, 106.

Precision Forging Pinion Gears

Condensed from "Tool Engineer"

A new Timken-Detroit process for coining differential pinions is recognized as a revolutionary development in gear making. Claims are made that more than 1,500,000 lbs. of high grade steel is saved, in addition to thousands of man- and machine-hours. This differential pinion is of a coarser pitch and of different tooth form than the ordinary differential pinion with involute tooth form.

Using a Maxipress weighing about 300,000 lbs. and of about 2000-ton capacity, the coining process was tried on the pinion rather than on the side gear because: (1) There were double the number of pinions required, and volume was essential; (2) the pinions usually failed in service and forging increased the strength of pinions; and (3) dies were cheaper.

After months of experimentation, perfect pinions were produced, but only 10 to 50 pieces could be produced before the die would either burst or start to wash at the point facing the flank of the tooth. To remedy this, a depression was left in the back face of each tooth and of sufficient area to absorb the metal displaced. This proved to be the solution. Heating had to be uniform.

Specifications applying to No. 1 or smaller of two high traction pinions call for 7 teeth, and 12 teeth in mate; pitch is 3.27, and high traction pressure angle 25 deg.

After a 3-step forging process the pinion is trimmed to remove flash, following which it is made in coining dies. One of the secrets of getting so many pinions from each set of dies is found in the die reinforcement. It resists any tendency of the dies to spread or break.

As to the type and cost of equipment in use, the Maxipress No. 6 costs about $83,000. However, the work could be done on a No. 4 Maxipress, costing $41,000. Capacity on a No. 1 or smaller pinion is 320 per hr., and on the No. 2, 250 per hr. A controlled heating furnace costing $6,000 and a No. 12 Erie trimming press costing $3,500 are the only other items.

Forging and coining operations consist of: (1) shear stock to length; (2) upset, break down and finish forge; (3) cold trim; (4) pickle; (5) shot blast; and (6) semi- and finish-coin. Following finish coining the pinion is inspected and checked by Go-No-Go gages Each 100th pinion is checked.

Advantages claimed are: (1) Accurate reproduction of the theoretical form of tooth desired; (2) exact duplication of form; and (3) increased strength due to greater metal density and no cutting across flow line of steel.

—R. J. Goldie, *Tool Engineer*, Vol. 12, June 1943, pp. 67-71.

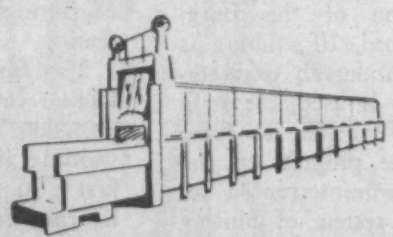
MODERN FORGING FURNACE HEATING PRACTICE

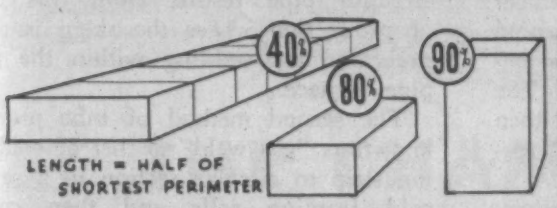
WORLD WAR II has served to accelerate the development and application of industrial furnace engineering. Management has, for some time, been conscious of the advantages of modern hardening, drawing, annealing and normalizing furnaces. It remained for the current war to emphasize the importance of modern forging furnace heating practice.

Non-uniform heating, as well as overheating, is responsible for a large part of forging problems. The advent of extremely close inspection of airplane engine forgings, plus a marked increase in the use of alloy steels, has served to focus attention on this matter.

Prior to the War, the pusher furnace was the accepted production type of equipment for heating billets. A number of forge shops employed the open slot or end heating type of forging furnace where production was small or where the size or shape of the billet would not permit processing in the pusher furnace. In the slot furnace, there is no control of heating time. Fuel consumption exceeds that secured in the production type furnaces by as much as 100%. Overheated or burned steel is a common problem. Working conditions are very bad. Furnace maintenance is excessive.

In the pusher furnace where the billets rest on skid rails or refractory hearth, heat is only applied to the top and end areas of the billets. In the more modern design, the billets are exposed to underfiring during the preheating period. This usually involves water cooled skid rails with their attendant cold spots, scratching and maintenance. In a pusher type billet heating furnace the charge is essentially a continuous slab with heat applied to the top and edges only. Assuming a billet size in which the length is equal to one-half of the short perimeter, there is exposed to heat absorption in the pusher furnace only 40% of the entire surface area of the billets. Since heating time is directly proportional to area exposed, under conditions where temperature and billet size are fixed anything that can be done to increase area exposed to heat will result in more uniform heating, shorter heating time, less scale, lower furnace temperatures and less furnace maintenance.

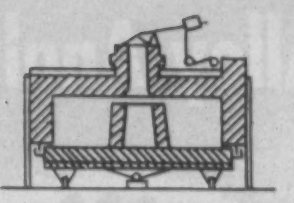




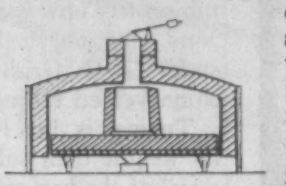
To accomplish this, the George J. Hagan Company accordingly applied the existing rotating hearth heat treating furnace to forging service. In the rotary hearth furnace the billets are spaced from each other, resting flat on the hearth. This increases the area exposed to heat to 80%. Results were so good that we then developed the application of a refractory hearth material that permits standing the billets on end. In this instance, area exposed to heat increases to 90%.

We also applied the burners in such a manner as to provide a swirling or rotary motion to the combustion gases. Thus, as the billets travel around with the hearth we continuously expose all areas except one end or one side to heat. Since there is no fixed spot on which the billets are loaded, the hearth refractory is also given time to recuperate and absorb furnace heat.

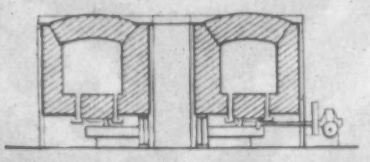
The inherent operating and mechanical problems involved in the application of the rotary heat treating furnace to high temperature applications were solved by designing a furnace structure in which the hearth has a greater diameter than the furnace chamber. The outer portion of the hearth rotates beneath the side wall and not inside it. The hearth expands without affecting the horizontal clearance between the hearth and the side wall. This eliminates the vertical clearance between the hearth and the wall which in operation serves to accumulate slag, scale and debris in general and finally results in freezing or binding the hearth to the side wall.



A flat suspended arch as developed for the large pusher furnaces and boiler applications was used in place of the dome or doughnut types of arch. This construction eliminates all refractory troubles due to expansion or pinching. The flat suspended arch also permits the installation of the furnaces adjacent to the extremely large forging hammers in use today. There being no concentrated load and no cumulation of stresses in the flat suspended arch, vibration and shock have no ill effects on it.



A solid pancake hearth is employed in place of the annular hearth. This eliminates the clearance between the hearth and the inner furnace wall and the sealing means required to close this opening. The pancake hearth permits the use of a radial thrust bearing to anchor the hearth in a fixed position at a central point and have all expansion and movement take place from this center bearing. Locating a hollow brick column at the center of the solid hearth so that its top opening coincides with the exhaust stack in the furnace roof provides a splash wall to direct the swirling combustion gases and also a means of pulling these gases down to furnace hearth level and exhausting them from the furnace chamber at this point. This assists in keeping combustion gases and heat at the bottom of the furnace. The application of chrome ore monolithic hearth materials in place of refractory brick assists materially in maintaining a flat hearth area that resists abrasion and wear.



We have successfully applied 170 of these furnaces for heating billets for forging, pressing and upsetting. Furnaces are available in a full range of capacities varying from a few hundred pounds per hour up to 10 and 12 tons per hour. Billet sizes heated vary from 1″ to 10″ square and billet weights vary from a few pounds up to 400 lbs. each. Some billets are pre-formed at the mill. Other billets for some of the more complex airplane engine forgings are heated three times—in the form of a solid billet, a pancake, and a rough forging.

The rotary hearth furnace, as applied in the forging industry, supplies a continuous flow of billets heated more uniformly to the best forging temperature under automatic control of time and temperature. Heating times have been reduced as much as 40%. Fuel consumption as compared to batch type equipment has been decreased up to 58%. Forging temperatures need not exceed 2300°F. Scaling is decreased materially. Burned and underheated steel is eliminated. One plant reports the forging of over 30,000 pieces without a rejection. Labor conditions are vastly improved. Furnace maintenance, because of lower operating temperatures and design, is a minor cost consideration.

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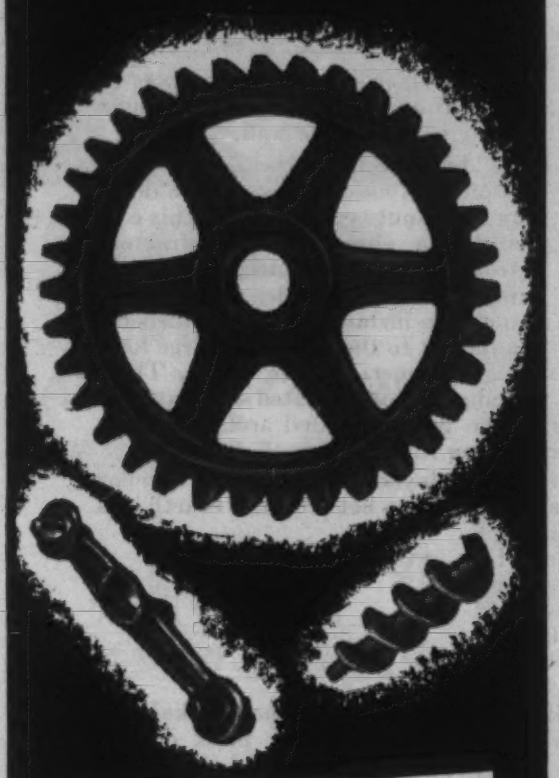

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Steel Tubing Welded by Various Methods

A Composite of A. W. S. Papers

A session on tubing at the October meeting of the American Welding Society was featured by papers on electric-resistance welded tubing and on oxyacetylene-welded tubing. The three abstracted here contain a wealth of information on the processes used, finishing operations, results obtained, test methods, etc.

Oxyacetylene Machine-Welded Tubing

Automotive torque tubing for propelling the weapons of war must combine lightness and strength and must be able to rotate at high speeds while carrying heavy loads. On this account the production of welded tubing has now assumed an importance beyond anything it knew in time of peace, states G. C. Gridley in his paper on machine-welded tubing.

Tubing is far lighter and stronger for its weight than solid bar because the core metal of the bar contributes far less strength per lb. than does the outer metal. Also, welded tubing in this use has one decided advantage over seamless. It can easily be manufactured without measurable variation in wall thickness. This is important because variations in wall thickness are likely to cause whipping at high speeds and buckling under heavy loads.

In the mill operated by the Mechanics Universal Joint Division of the Borg-Warner Corp. in Rockford, Ill., tubing is welded at high speeds under an oxyacetylene flame. Coiled strip is used, the strip ends being butt-welded together to form a continuous strip. The progress of the strip through the mill is uninterrupted because of a compensator system of pulleys which continues feeding strip into the mill from a 240 ft. slack loop during the interval in which normal feed is uninterrupted for butt-welding.

The strip, relatively free from camber and snake, passes first through straightening rolls which, mounted under spring tension, remove the effects of coiling. The strip ends are squared by a shear and then held in position for butt-welding by pneumatic clamps.

Passing through the compensator system, the strip next encounters ten pairs of breakdown and forming rolls which gradually depress the center of the strip and roll the edges upward until the transition from flat to round is almost completed. Only a narrow seam is left open at the top of the tube in order to insure a high-quality weld.

The welding is accomplished by a two-torch, 81-orifice, graduated-heat unit designed to utilize to the best effect the divers heating characteristics of different oxyacetylene mixtures. This is done by using a high percentage of oxygen in the first flames of the preheating section and progressively less oxygen in the succeeding flames until, in the welding section, the flames become neutral and non-oxidizing.

Gradual cooling is effected by water quenches which play first on the areas adjacent to the seam and then on the seam itself. After straightening, sizing, and reducing of o.d. from 0.025 to 0.015 in., the tubing is cut into measured lengths by a rotary cutoff.

Through multifarious straightening, balancing, chamfering, and testing machines the special lengths of tubing pass to pressing-in and welding machines which attach stub ends, yokes, and sleeves to the tube ends. Elaborate balance and torque testing machines insure the highest quality in the finished product. Tubing which does not return to its original shape after the rigorous torque test is scrapped.

Any out-of-balance in satisfactory tubing is corrected with a lead spray. The finished parts turned out in this mill go into a large number of fighting tanks, trucks, planes, etc. As yet there has been no word of failure in the longitudinal weld area of any one of them.

Welded Tubing for Construction Work

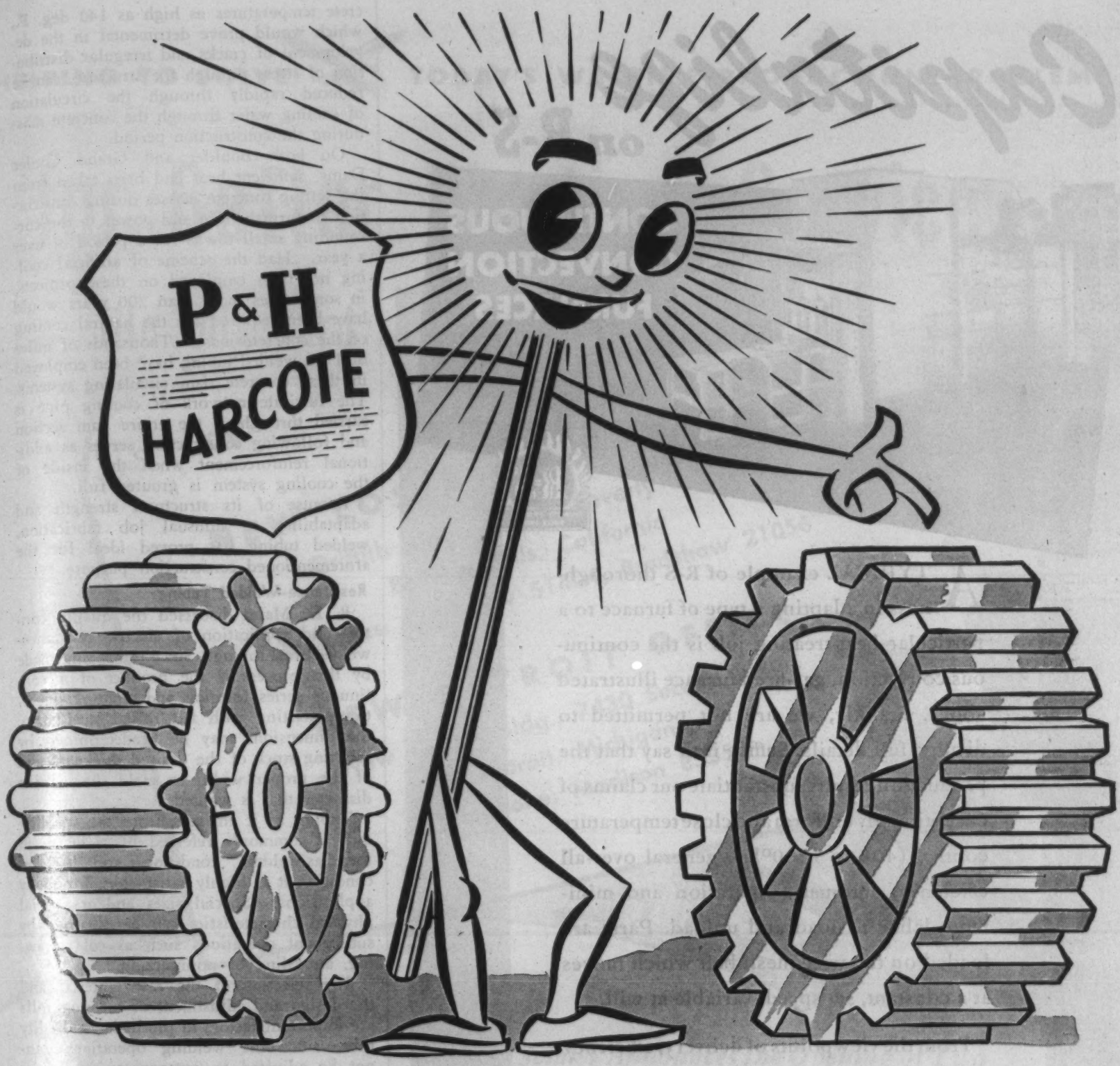
Recent developments in the manufacture of fusion weld tubing by the gas process have resulted in wide application for pipe and light wall tube in many construction fields, according to A. C. Weber. In addition to welded structural frames, such as small span trusses, stair rails, portable building frames, etc., many unique applications of tubing have been possible through the economy and increased strength effected through the use of oxyacetylene welded seams.

The fusion weld method of pipe manufacture involving the heating of flat skelp to 2600 deg. F. prior to forming and welding in the drawing bell is considered first. In this process the heated skelp delivering from the tube furnace is carried through a series of oxyacetylene burners which bring the skelp edges to a fusion heat immediately before drawing into circular shape and welding. Extremely high strength pipe results from this method of production where the skelp is actually preheated for welding within the regular pipe furnace.

The second method of tube production known as "gas weld" is that of cold forming strip to circular section in a series of cold forming rolls and then complete fusion welding beneath a gas welding head which localizes all heating to the seam.

In addition to the numerous war-time uses of welded tubing in bomb burster tube, incendiary bombs, ships' railing, and a multitude of other items of the arms industry, considerable gas welded pipe has been employed in unusual construction work. Expansion sleeves for concrete pavement construction in airport streets and highways, and a special fabrication for building scaffolds now so frequently employed on building, cleaning and repair jobs are two such uses.

By far the outstanding application of welded tubing in construction work has been its use in the artificial cooling systems for large concrete masses such as Boulder, Grand Coulee, and Shasta Dams. In these structures the rate of construction speed and tremendous mass of concrete require that some method of artificial cooling be employed to carry off the heat developed during the hydration of the cement. Con-



MEET THE CHAMPION "BUILDER-UPPER"

When it comes to rebuilding worn parts, Harcote is the real champion electrode that gets in there—puts on a hard surface that's tough and long-lasting. An important time and money-saver, too! When worn parts would take weeks to replace—Harcote does the job quickly—at a fraction of the new part cost—gives you a part that will outwear the original.

Harcote is ideal for welding on carbon steel, low alloy and high manganese surfaces.

See your P&H representative for procedures. Also ask about P&H electrodes for any other welding requirements.

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Capitalize on R-S

A TYPICAL example of R-S thoroughness in adapting a type of furnace to a particular heat-treating job is the continuous convection, gas-fired furnace illustrated above. Frankly, we are not permitted to divulge full details. Suffice it to say that the production results substantiate our claims of exceptionally uniform and close temperature control (400 to 1300°F.), general over-all efficiency, automatic operation and minimum labor to load and unload. Parts are loaded on the wire mesh belt which moves at a constant, set speed, variable at will.

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crete temperatures as high as 140 deg. F., which would prove detrimental in the development of cracks and irregular distribution of stress through the structure, can be reduced rapidly through the circulation of cooling water through the concrete mass during the construction period.

On both Boulder and Grand Coulee Dams, sufficient heat had been taken from the setting concrete masses during construction to furnish light and power to the surrounding small towns for a period of over a year. Had the scheme of artificial cooling not been employed on these projects, in some cases more than 200 years would have been required for the natural cooling of the concrete mass. Thousands of miles of 1 in. welded tubing have been employed in these concrete dam circulating systems. The intricate network of cooling pipe is carried throughout the entire dam section and following construction serves as additional reinforcement when the inside of the cooling system is grouted full.

Because of its structural strength and adaptability to unusual job fabrication, welded tubing has proved ideal for the aforementioned construction purpose.

Resistance-Welded Tubing

R. D. Malm discussed the quality control and application of electric resistance-welded steel tubing. Since the tubing made by this process is the product of a continuous series forming and welding operations, starting with flat rolled steel strip, the dimensions may be predetermined by selecting stock of the desired thickness and of the proper width to yield the outside diameter that is wanted.

Tubing as it emerges from the welding mill is commonly referred to as being in the "as-welded" condition, and in that condition it is highly satisfactory for many applications. Special sizes and/or special physical characteristics can be obtained by subsequent operations such as cold drawing, annealing or normalizing.

The selection of the raw material and the design and adjustment of forming rolls are important factors in producing a quality tube, since the welding operations cannot be adjusted to compensate for variations in steel quality nor for poorly formed welding edges. That is, welding is only one operation in a sequence, and the scope of quality control is all-inclusive.

Some of the processing operations subsequent to welding constitute severe tests of the quality of the weld. For example, when a tube is drawn through a die it is subjected to combinations of compressive, tensile and shearing stresses, and the yield point is of course exceeded. In the straightening operation, as the tubing passes through each set of straightening rolls the weld is subjected to an alternation of stress twice during each revolution, with varying degrees of shear and torsion added. This is an unique situation in the testing of welds, wherein a welded product is stressed beyond the yield point of the steel continuously throughout the full length of the weld, and still the tested article remains within mechanical tolerances.

Many special tests are used for special conditions. Since there are a number of characteristics which affect the quality of the tube, there is no one test which can be applied universally. Therefore, complete testing facilities are essential.

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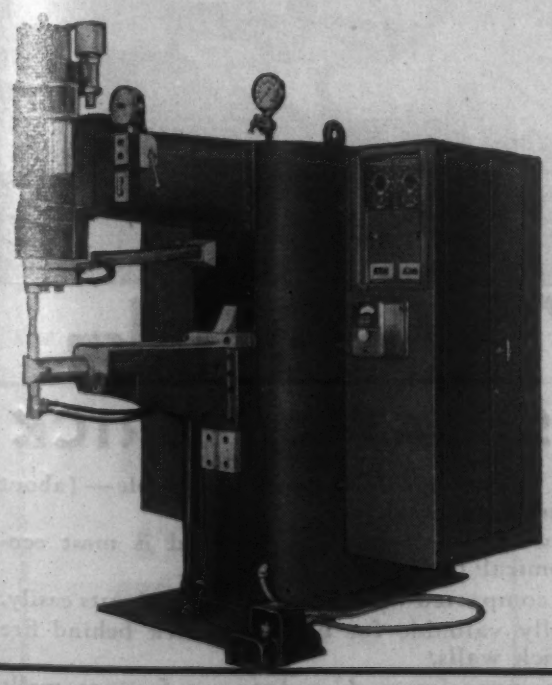

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Tool Life and Efficiency

Condensed from "Mechanical World"

Methods and practices for increasing tool life and efficiency are given in a leaflet (No. 9) issued by the Machine Tool Control of the British Ministry of Supply.

It is pointed out that reduction of speeds or feeds in hobbing will not compensate for a dull tool. Too small a feed frequently traps chips and gives the work a "plucked" appearance instead of improving finish. Too high a speed causes the hob to rub, spoiling finish and the hob.

Milling cutters are frequently too small for the job, have too many teeth, or have plain teeth when helical teeth would be better. The ideal number of teeth for cutting steel is twice the diameter of the cutter plus two, while for aluminum or soft alloys the number is the diameter plus two. Helical flutes give smoothness of operation because their cutting edges engage the work progressively, and are preferable where wide cutters are necessary. The usual angle is 45 deg., although up to 52 deg. may be used for special work. Straddle milling should be done with half side mills, with a flute angle sufficient to carry the chips away from the work. Staggered tooth mills are not recommended for this work.

Careful sharpening is one of the main factors in prolonging the life of a broach. On hydraulic broaching machines a pulling load should be fixed, by calculation or experience, and the broach should be reground when this load is reached. Great care should be taken to ensure that the radius at the root of the tooth blends perfectly with the new face so that no ridges impede the flow of chips during broaching. The bigger the radius and the better the blend the better the chip flow will be. A rubber bonded wheel should be used for polishing after grinding. Broaches should be stored in wooden boxes or racks.

To obtain best results from cemented carbide tools, speeds from two to six times those for high speed steel tools are recommended, with moderate feeds. Machines of ample power for the resulting loads are necessary, with substantially designed tool posts. Cemented carbides retain cutting edges up to 900 deg. C. (1650 deg. F.), but because of low heat conductivity localized heating must be avoided during grinding. Tool breakage may sometimes be avoided by increasing nose radius, introducing or increasing lead angle on the cutting side, and by use of a step shank or "bull nose" tool. Grinding wheels should run at surface speeds up to 2600 ft. per min., with direction of rotation from the tip toward the shank.

For grinding Fellows type gear shaper cutters, an expanding pin adaptor should be used, with the back face of the cutter against a true faceplate. The cutter should be traversed at an angle of 5 deg. to the grinding wheel, with surface speed of 6000 to 6500 ft. per min. for the wheel and about 120 ft. per min. for the cutter. Depth of cut should not exceed 0.001 in. per traverse, and the traverse speed should be about 20 ft./min. Grinding is done wet.

Each tooth of a helical cutter has to be individually sharpened, and special attachments have been developed for use on most types of cutter grinding machines. Grinding is done dry, with sharp wheels, at a peripheral speed of 4000 to 4250 ft. per min.

—*Mechanical World*, Vol. 113, April 2, 1943, pp. 352-353.

Abrasive Cloth Tools

Condensed from "Products Finishing"

Abrasive cloths and papers in the form of sheets, discs, and belts are well-known products. Today, under the pressure of greater speed in finishing metal parts, many special shapes of abrasive cloths have been developed for use on portable and flexible shaft machines.

"Spirabands" are abrasive cloth sanders of cylindrical form which may be mounted on a mandrel and used for removing burrs or machine marks along edges or from flat or concave surfaces. They are available in diameters from ¼ inch to 6 inches and in all grit sizes.

Discs with radial slots are useful for burring the edges of holes. Two such discs placed back to back will burr both sides of a hole, one side on pushing it through and the other side on drawing it back.

"Spiracords" are spirally wound cylinders 8 inches long and available in diameters from ⅛ inch to ¾ inch. They may

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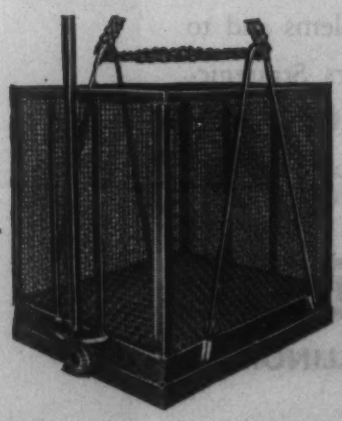

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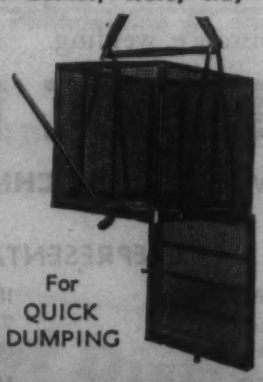

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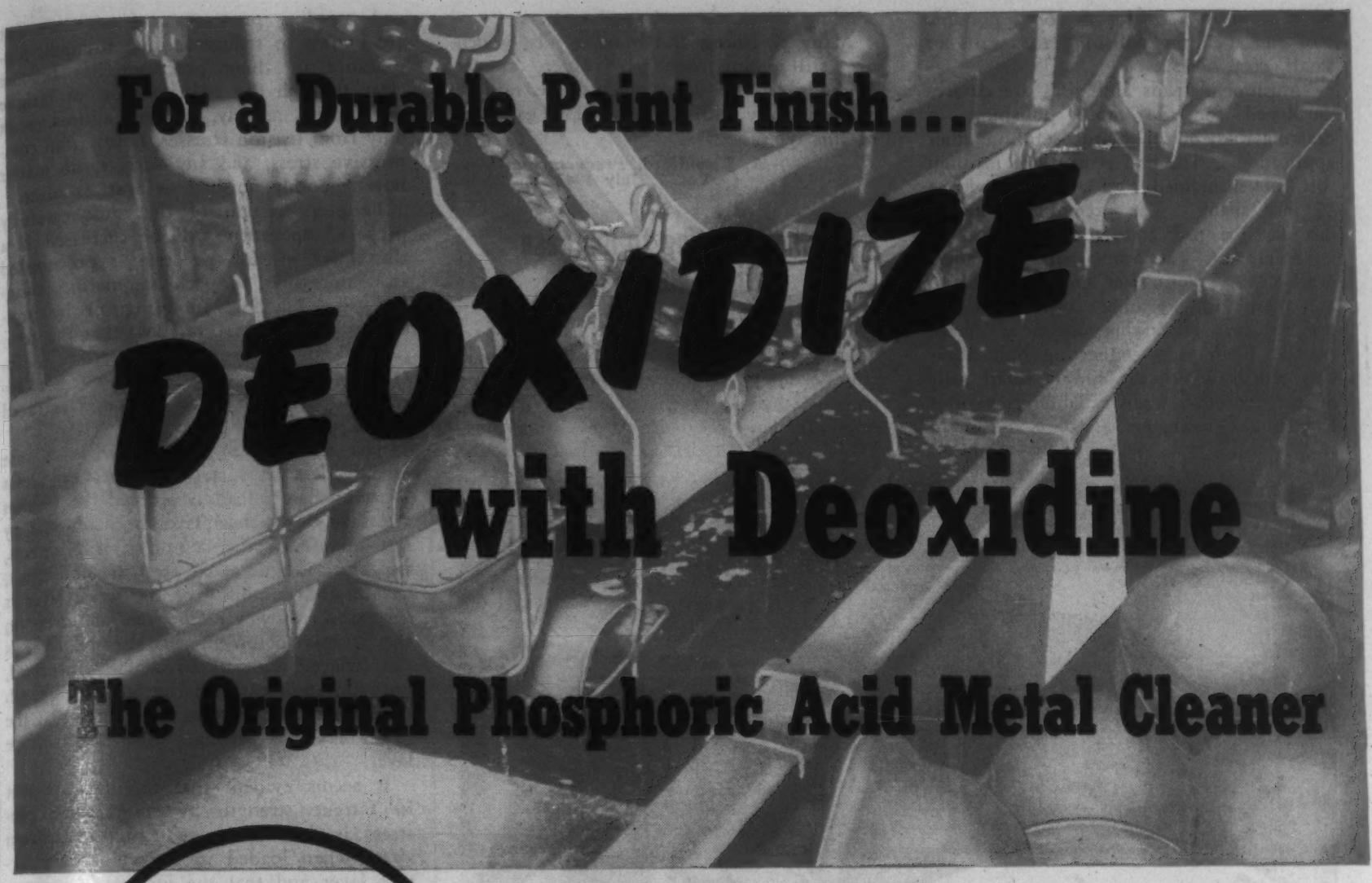

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be chucked in a drill press or a portable tool and used for polishing the walls of small, deep holes.

"Mushroom" pads and discs are devices developed for the rapid polishing of drawing dies, but they are useful in other applications. The pad is made of medium soft rubber molded over a fixture with a ¼ inch shank. The premolded abrasive disc fits the pad and is cemented to it.

"Spirapoints" are cone-shaped abraders available in various sizes and tapers. These are useful in polishing concave or depressed areas of varying radius or depth, *e.g.* the flutes on a connecting rod. Abrasive pencils, which are simply small rolls of abrasive cloth, are available in various lengths and diameters and are useful in sanding fillets, channels and corners.

Many polishing and burring jobs which are still being done by older, slower methods can be done much more rapidly and efficiently with "abrasive cloth gadgets" of this type.

—A. J. Sidford, *Products Finishing*, Vol. 7, July 1943, pp. 26-32.

Shot Blasting to Increase Fatigue Resistance

Condensed from "S.A.E. Journal"

Fatigue strength of machine parts made from ordinary structural materials can be increased merely by the extension of processes that have been used for a long time, and avoiding processes and practices that are known to reduce fatigue strength. Significance of these processes has become clear through the new concepts of fatigue phenomena, namely, fatigue failures result only from tension stresses, never from compressive stress, and any surface, no matter how smoothly finished, is a stress-raiser.

Fatigue strength of the most carefully prepared specimen will be increased if a thin layer of the specimen is pre-stressed in compression, by peen hammering, swaging, shot blasting, tumbling, or by pressure operations. Tests show that the compressive stressed surface is effective in increasing the fatigue strength whether applied to highly finished or rough surfaced specimens.

The most plausible explanation of the effectiveness of surface compression stress is that when a load is applied the tension stress in the surface layer becomes less by the amount of the compression pre-stress, and since fatigue starts from tension stress, the fatigue durability of the weak layer is increased. However, the tension stress in the material below the pre-stressed layer is not reduced but may be actually increased, notwithstanding which the fatigue strength is increased. It follows, therefore, that the lower layer is stronger than the surface layer.

It seems evident that the improvement in fatigue strength by compressive pre-stress is due to the reduction in tension stress when loaded in the vulnerable surface layer and that the increased compressive stress in a specimen stressed from zero to a maximum in either direction does no harm.

Further evidence of the extra vulnerability of the surface layer is found in the behavior of specimens having increased strength in a thin surface layer, as in thinly nitrided specimens. Fatigue failures in such specimens also start below the surface and show greater fatigue strength than the same material in the unclad state. The nitrided specimen is probably superior to those using other forms of hard cladding because, in addition to higher physical properties of the surface layer, this layer is in a state of compression, and therefore less notch sensitive.

Often the strength of machine parts has been decreased by too intense peening. Fatigue strength is increased as the intensity of peening or rolling is increased until a maximum improvement is obtained. With more intense peening or rolling, the fatigue strength rapidly decreases below the original strength and the part will be damaged due to excessive internal tension stresses.

A practical method for indicating the compression in the stressed layer consists of a thin strip that is attached to a heavy base. This strip is rolled or peened with the same intensity that is given to the machine part, and when removed from the base it will be found to be curved with the convex surface on the cold worked side. The curvature is measured by an indicator, which can then be interpreted in terms of the depth of the stressed layer.

Stress-Producing Treatments

Nitriding improves fatigue strength but it can be overdone as in case of peening

Whether you have a small plant with only a few machines, or a large plant with hundreds of machines, we have dust collecting equipment to fit your particular requirements—from units with 700 CFM capacity to operate independently on separate grinders, to large central system installations of 100,000 CFM capacity.

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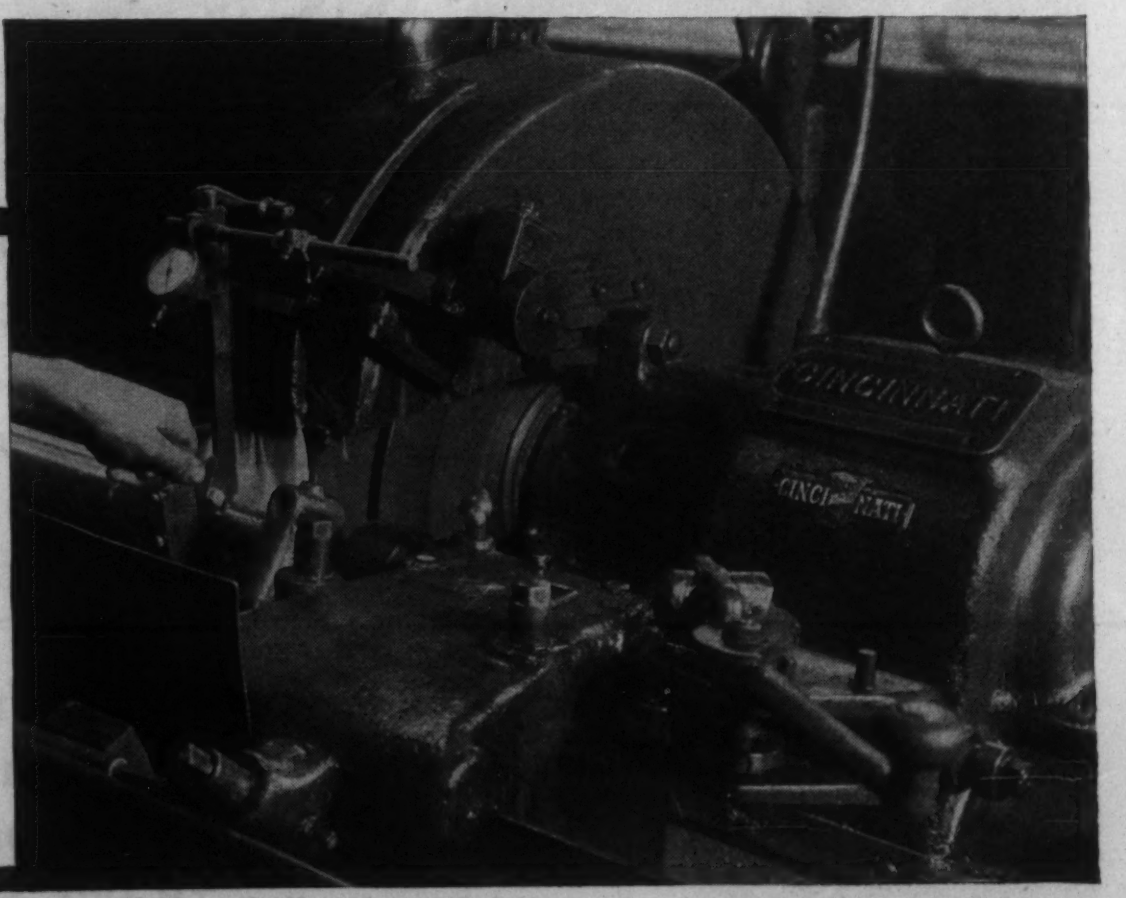

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Care must be used in nitriding thin sections to gage the depth of the layer in proportion to the thickness of the section being nitrided.

Residual stresses due to quenching from relatively low temperatures may reach considerable magnitudes and may be harmful or helpful to fatigue durability depending upon whether the trapped stresses augment or diminish the tensile stresses from the applied loads.

Peening does not prevent corrosion but it prevents the ill effect of corrosion in promoting fatigue. Similarly nitriding, carburizing and other treatments that produce compressively stressed surfaces afford protection against the effects of corrosion and surface bruises.

Fatigue strength of bolts and studs stressed in tension is dependent upon initial tension applied by the nut and upon elasticity of bolted members. Therefore, washers, gaskets, etc., that add to the elasticity of the bolted assembly are definite fatigue hazards. Short studs or bolts are more vulnerable to fatigue than long ones. Plating screw threads with soft metal to avoid corrosion is a definite fatigue hazard.

Pitting of gear teeth is a form of fatigue that is induced by tensile stress from compression loads on the contacting tooth surfaces. Design factors that are effective in reducing load concentration at the ends of the tooth, barrel shaping or equivalent, also reduce the contact compressive stress. The relative curvature, and therefore the contact compressive stress, can be varied by choice of pressure angle.

In high speed gears pitting may occur when gears are transmitting no load, although this form of transmission trouble is rare. High speed gears should be lubricated by jets of low viscosity oil directed at the teeth as they are coming out of mesh, not on the incoming side. This will wash away heat of friction while it is still on surfaces of the teeth.

In design of machines and equipment for heavy duty, where the number of units is small, present practice of designing to large factors of safety is justified because the expense involved in preparing designs to approach exact requirements would far exceed the savings in weight and material.

In practical fatigue testing of machine parts, it should be obvious that comparisons of material, designing or processing cannot be made unless tests are run to failure and comparisons are made on a number of stress cycles that each will endure. This is true whether or not the part is required to withstand a large number of stress reversals at maximum load.

—J. O. Almen. *S.A.E. Journal*, Vol. 51, July 1943, Trans. pp. 248-268.

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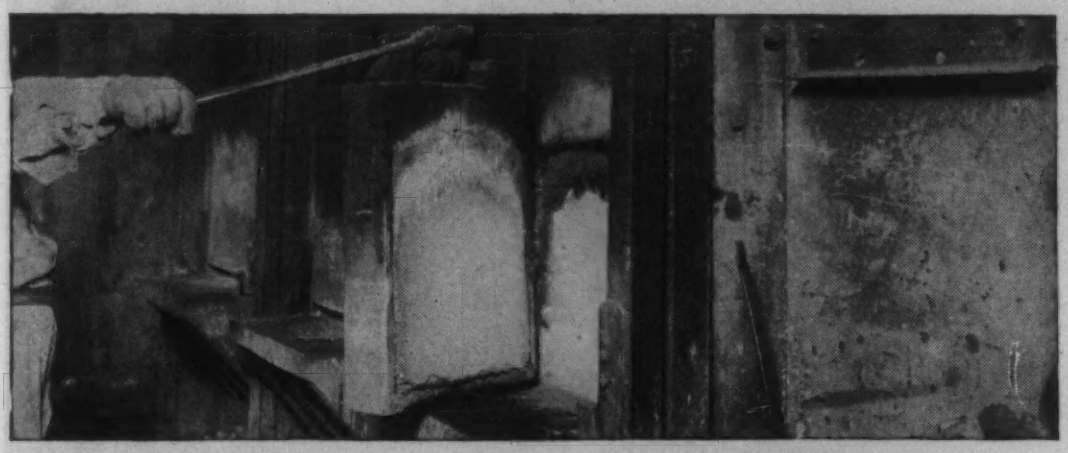

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Dry Cyaniding

Condensed from "Heat Treating and Forging"

Commercial methods for producing case hardness are nitriding, cyaniding, solid, liquid and gas carburizing. Solid or pack carburizing is used where case depths of more than 0.025 in. are required. On parts requiring definite core properties and minimum distortion, the nitriding process is used. The straight sodium cyanide salt bath process combines some of the characteristics of carburizing and nitriding but it is good only up to 0.010 in. case. Various types of accelerated salt baths are used for case depths up to 0.125 in.

"Dry cyaniding" is the production of a hard, wear resistant carbide-nitride case on steel by means of a dry gas atmosphere. The carburizing effect is obtained by the use of a base gas, a neutral generator or a city gas, enriched with natural gas, propane etc. The nitriding is produced by the injection of anhydrous ammonia.

In the laboratory of the Buick Motor Division, General Motors Corp., test bars were carburized in an atmosphere of 10 per cent ammonia and 90 per cent manufacturer's (coke oven) gas for three hours. The maximum N_2 content was found at 1400 deg. F. Carbon concentration was low at 1400 deg. F. with the maximum at about 1600 deg. F. Results of the experiment applied by using different combinations of gases, temperatures and time produced a variety of satisfactory case conditions.

The dry cyanide case has greater resistance to tempering than those produced by straight carburizing. Parts can therefore be drawn at higher temperatures after hardening for better core physicals. Low range plain carbon steels and free machining screw stocks are readily given a uniformly file hard surface with an oil quench. Therefore, it has been found profitable to use a continuous furnace to treat parts form-

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erly cyanided in salt baths. Long and costly cleaning operations are eliminated. The prime requisite in the furnace is a completely muffled heating chamber.

Gas Generator

For good control of gas carburizing process, it has been the practice to use a nearly neutral carrier or dilutent gas (1) to dilute the carburizing gas so that soot will not deposit on the furnace and stock, and (2, to maintain muffle pressure sufficient to prevent air from entering and contaminating the atmosphere. The necessary pressure is 0.035 in. minimum of water per foot of muffle height. Several types of generators are used but the dilutent gases produced must be free from carbon dioxide, oxygen and water vapor and be low in saturated hydrocarbons such as methane, ethane, propane etc.

Where natural gas is available, the simple cracking unit of a mixing manifold, a combustion chamber and a cooling tower may be used. As the product is too high in CO_2, ammonia can be added to make it suitable for dry cyaniding. City gas used directly with ammonia will produce the same results. The carbon availability of carrier gases is increased by the addition of common carburizing gases such as methane, propane, butane etc. With the ammonia they are introduced to the carrier gas in the manifold lines before entering the furnace. The flows are controlled by sharp edged orifices and regulators close to the furnace.

The set-up most used in the Buick plant for dry cyaniding involved a continuous type radiant tube furnace in which the stock is quenched into an oil tank at the discharge end without exposure to air. The operating temperature was 1550 deg. F. and 700 cu. ft. per hr. of generator gas gave the necessary muffle pressure. From 5 to 25 cu. ft. per hr. of propane, and 50 to 150 of ammonia were added. Usually the time cycle was 1½ to 2 hours. Inspection requirements were a file hard surface and minimum case depth of 0.007 in. Most parts were shovel loaded on low-sided, perforated trays carrying 20 to 80 lb. per push. The weight is governed by the load density characteristics of the part. This is important as the gas must circulate through the stock to produce uniform results. Small shafts and shift rails may be held vertically to eliminate warping in quenching. A light etching band on the outside of the case, associated with high carbon content, represents a desirable condition. Excessive amounts of this "white layer" on alloy parts that are straightened after hardening and those subjected to high pressure in service are not desirable. The amount and character of the layer can be varied by adjustments of the cyaniding atmosphere.

Rotary Retort

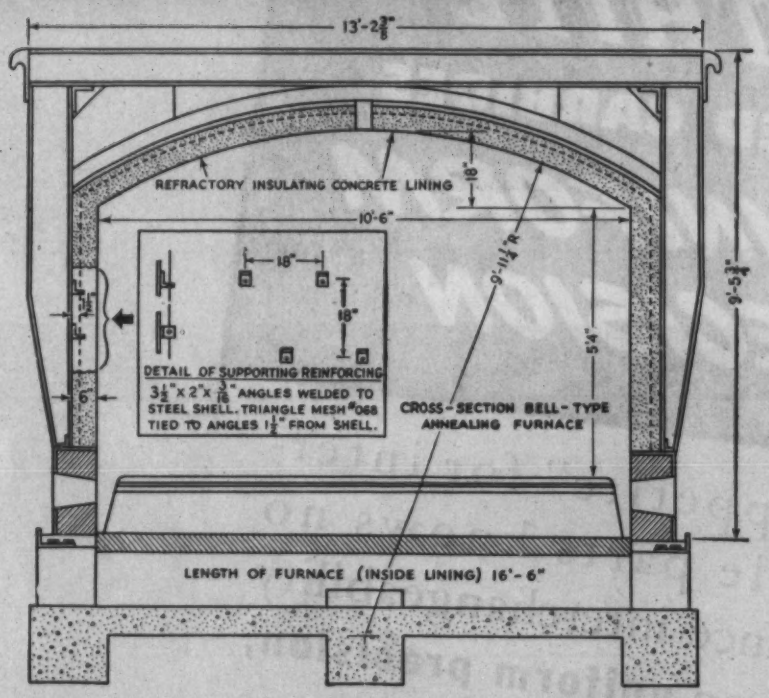
Rotary retorts were used to dry cyanide a number of small parts. Shafts requiring sufficient surface hardness to withstand the wear of needle bearings were treated with 66 cu. ft. per hr. of city gas, 10 cu. ft. per hr. of ammonia and 2 cu. ft. per hr. of propane at 1700 deg. F. If the availability of the carbon and nitrogen is too great for the rate of diffusion into the steel at the temperature used, the case is apt to spall and give trouble in grinding because of brittleness. With preliminary experiments, the process can be applied to any suitable production furnace.

A modified dry cyanide treatment on automotive torsion shafts shows beneficial results. From 0.020 to 0.025 in. case was put on a core of 0.30 per cent carbon alloy steel using generator gas with an addition of 1 per cent propane and 1 per cent ammonia. The cycle was 2½ hr. at 1550 deg. F., the shafts being tempered at 450 deg. F. after hardening. The medium carbon core hardened to give support for the light case and addition of 1 per cent of ammonia gave the case sufficient draw resistance to retain its hardness and wearing properties.

An investigation of the use of high ammonia content and slow cooling from the carburizing heat showed satisfactory file hard surfaces, in the range of 1350 to 1450 deg. F., using 35 per cent ammonia, 20 per cent natural gas (or 10 per cent propane) and the balance carrier gas. Lower temperatures may be used but increase the time cycle. The pieces were cooled from 1450 deg. F. to 1200 deg. F. in the furnace with the gas on and then air cooled. The almost solid "white layer" is necessary to obtain the hardness with a slow cool. With this treatment a small amount of distortion is obtained. It is not applicable where high core properties are required.

—L. L. Clark & C. H. Leland, *Heat Treating & Forging*, Vol. 29, June 1943, pp. 295-300.

JOINTLESS LINING SAVES HEAT IN ANNEALING FURNACES



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Refractory Concrete and Refractory *Insulating* Concrete, both made with LUMNITE, are meeting the wartime needs of many steel mills. We offer the help of our representatives in making the most efficient use of LUMNITE, which is now available only for service in essential war production. The Atlas Lumnite Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York City.

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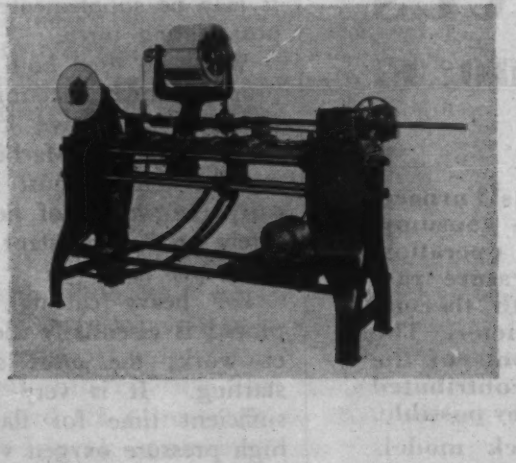
NEW TWIST TESTER FOR WIRE

Model T-3 is a recent addition to the extensive line of *Scott Testers. This twist tester accommodates samples of from 2" to 8" in length, applying varying tensions of from ½ lb. to 17 lbs., as desired. Operation is accelerated by arranging the motor drive so that both ends of the specimen revolve. Others among the 60 models of Scott Testers perform wire tests from 1 gram to 1 ton for tensile, hysteresis, flexing, compression cutting of covering, etc., etc., with results graphically recorded for ease of reading and permanent reference.



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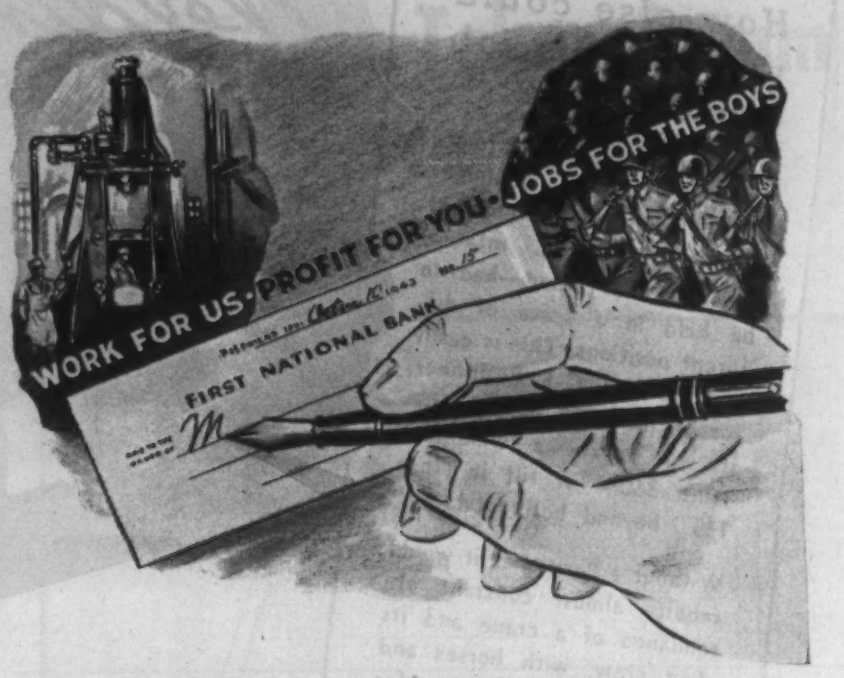


In a Post-war World

We desire to keep our plant in full production, and to provide work for our brave fighting men when they return. If you have ideas, inventions, or a product involving forging, heat treating, or machining . . . let's work together!

We are an old established firm, fully equipped to handle small and large drop forgings and upsetting operations. We are now on a 100% War Production Basis, but we are looking toward post-war conditions to keep our plant in full production to provide more jobs for the boys returning. We are in a position to carry on research, designing, manufacturing, and marketing, and, we have an enviable reputation for developing several patented articles on which we are paying handsome royalties.

So we extend a cordial invitation to forward looking men in our, and allied industries, to consult with us on post-war product developments. Let's *keep* American ingenuity employed at a full time wage.

For obvious reasons, it is necessary to have all communications addressed to the private box, given below. Your communications will be treated confidentially, as well as any interviews that may follow.

Please Address

ALL COMMUNICATIONS TO BOX 110

How else could you do this job economically?

To weld all seams and joints of this complex weldment down hand, the weldment had to be tilted, rotated, twisted, and turned—had to be held in a score of different positions. This is easily done with a C-F Positioner, for at the push of a button it will rotate a weldment (thru 360°) or tilt it (thru 135° beyond horizontal).

Without a Positioner it would require almost constant attendance of a crane and its sling crew, with horses and plenty of floor clearance for handling.

C-F Welding Positioners come in sizes and capacities up to 30,000 lbs. All are pedestal mounted and are adjustable for height.

Write for Bulletin WP-22.

CULLEN-FRIESTEDT CO.

1314 S. Kilbourn Ave.

CHICAGO 23, U.S.A.

Flame Cutting Heavy Sections

Condensed from an American Welding Society Paper

The last several years have seen a remarkable expansion in application of flame cutting of heavy sections. While such operations were started during the first World War, it is only recently that heavy cutting has been executed on a production basis. Today's war-time needs for fast delivery of heavy steel sections made it mandatory to flame out sections of almost unlimited thicknesses. This made it necessary to develop, or adopt, new technique and equipment to accommodate torch cutting of massive forged steel sections up to 42 in. thick without the aid of a lance. Flame cutting is said to be "heavy" starting with sections upwards of 20 in., except where conditions on thinner sections demand special handling.

A primary requisite for production heavy cutting is adequate oxygen and fuel gas supply. Oxygen must be piped with a uniform supply at pressures and volumes above a high minimum. Pipe and regulator sizes must be ample to supply large momentary loads. Fuel gas is generally acetylene, piped from medium pressure generating plants. On some applications propane (and acetylene) are used from cylinders.

Torches should be of the three-hose type for thicknesses ranging from 20 to 54 in. and should have an oxygen capacity of 6000 cu. ft. per hr. The preheat flames are of paramount importance, and must be of sufficient volume to result in a flame that will extend almost to the bottom of the cut. If available equipment does not supply sufficient preheat, it may be supplemented with an auxiliary post-heating torch.

We have used both an acetylene and a propane torch meeting the above specifications, and have cut upwards of 40 in. with both. Machines used for carrying the torches must be large enough to carry the weight of heavy-duty equipment safely, with a constant minimum speed of 1 in. per min.

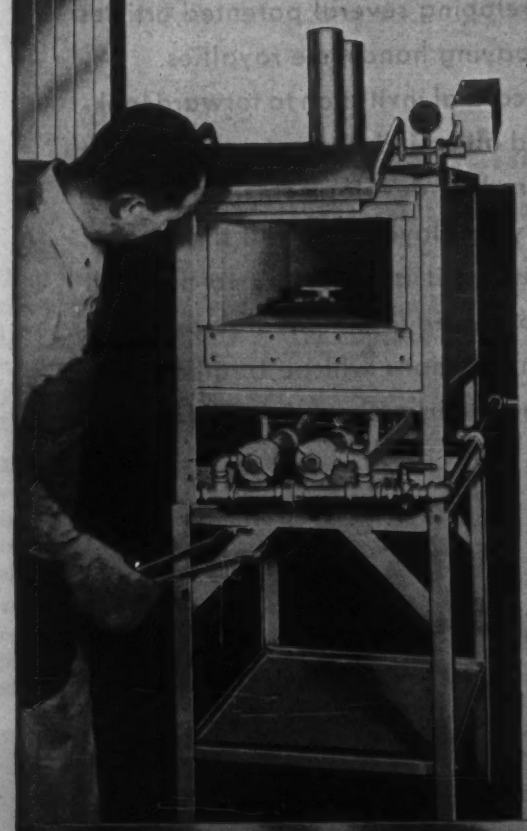
For heavy cutting the technique employed is essentially the same as for lighter work; the most difficult part is in starting. It is very important to allow sufficient time for flame preheat. The high pressure oxygen valve is then opened and the forward motion of the torch started a fraction of a second later, gradually increasing this motion to full cutting speed.

With these operations properly timed, the cut progresses down the face of the piece at a constant rate and without a sharp shelf forming at any point until it breaks through the bottom. At the instant the cut breaks through, the drag is generally rather long, but it will shorten to normal as the cut becomes completely confined.

Various special kinds of shape-cutting and single purpose machines are described, along with some outstanding heavy cutting jobs. Two three-dimensional profiling operations are discussed, one of which entailed cutting a 14 in. diam. hole in 36-in. thickness. A high light is the description of cutting five-throw crankshafts

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

113 Astor St., Newark, N. J.

Case #750 - It Takes Steam to Produce Sugar

The story of how Bigelow-Liptak engineering provided a good neighbor nation with a bagasse furnace enclosure to get increased mill capacity and provide the United States with more sugar when other sources of supply were cut off.

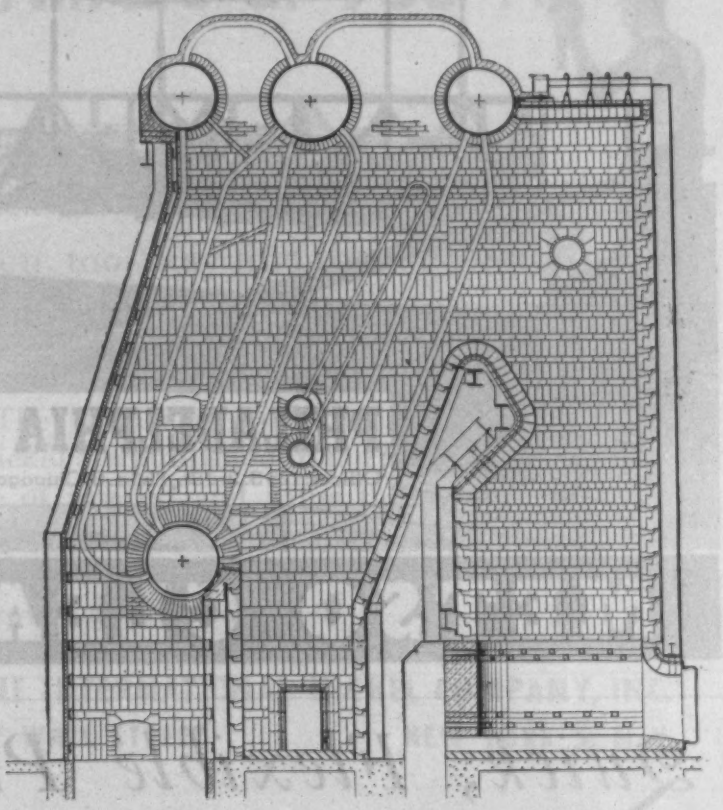
EARLY IN 1942 our sugar problem was critical. War had almost cut off our usual large imports from Hawaii, Puerto Rico and Cuba. Our supply would henceforth have to come from sources which had previously furnished only a small part. This meant extensive and hurried expansion in mills and sugar producing equipment.

One of these mills was located on the west coast of the Sierra Madre mountains down in Mexico. To secure increased capacity quickly, a new boiler would be required. The furnace problem would be difficult due to the burning of bagasse which is a very wet sugar-cane residue.

To aid the distilling process and the mixing of fuel gases with air for combustion, a *Ward* type furnace, with special provisions for admitting pre-heated air, would be used. Consequently, proper arch construction for directing the gases to the heating surface in this boiler would be of utmost importance. The contour and gas passage openings would have to be designed for the quality and quantity of bagasse to be burned. Air-tight wall encasements with minimum thermal losses and low maintenance would be necessary for continued heat efficiency and low operating cost. The inaccessible location of the mill added to the need for a low maintenance enclosure.

The Solution

In record time a Bigelow-Liptak furnace enclosure was making it possible for this good neighbor's mill to supply the United States with increased quantities of sugar. Furnace design was of utmost importance. The adaptation of complete suspended construction and the proper recovery of pre-heated air and its admission to the furnace were important Bigelow-Liptak contributions.



The Liptak Single Suspension Arch is ideally adapted to the unusual arch arrangement required by this Ward type bagasse furnace. The overhanging arch contour was easily provided with a few standard Liptak tile shapes in such a manner as to make an otherwise complicated construction simple. Here again the advantages of unit tile suspension are apparent, not only in erection but also in repair. Liptak radial tile are adapted over firing openings as well as around large access doors. Bigelow sealing arches at the front steam drum, together with a Bigelow expansion joint provide for maximum air tightness at this vulnerable point. A real saving in the cost of the boiler enclosure was made possible by applying a 3" Bigelow Budget Wall for the rearmost sloping baffle. This also considerably reduced the side wall area.

Bigelow-Liptak Heavy Duty 9" Double Suspended Walls are ideally adapted to the primary combustion chamber. Offset tile construction assures air-tightness. Double suspension design provides for ease of erection and repair. The sloping wall back of the combustion chamber as well as the bridge wall are 7" construction. Convection areas where service is not severe utilize thin Bigelow Budget Walls. These walls were made air-tight by the exclusive Bigelow method of applying insulation which requires no outer casing of any kind.

Is Yours a Special Enclosure Problem?

The significance of this problem and its complete solution by Bigelow-Liptak is much greater than any resemblance it may have to your own problems. It serves to demonstrate the value you may receive by taking your special enclosure problem to Bigelow-Liptak regardless of its type or size. Bigelow-Liptak's wide experience in designing enclosures includes every type of problem having to do with thermodynamics, ceramics and mechanics of materials. With Bigelow-Liptak there is no standard or set solution for every case. Individualized engineering, based on years of experience and sound engineering principles, is applied towards giving the customer the best and most economical solution to his particular needs. Our policy is to give first and foremost consideration to the needs of the user.

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Our engineering staff will be glad to send you interesting catalogs or tell you how you could secure increased service and economy by the use of Bigelow-Liptak Unit-Suspended walls and arches in your plant. Write today.

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● Metso Sodium Metasilicate Cleaners insure baths of high conductivity and stability under high current density. At the same time, the soluble silica content aids in quick removal of grease and oil and prevents dirt from re-depositing on clean work. In a large electro-tinplating plant the use of Metso Granular permits sheet steel to be run through cleaning bath at rate of 1600 feet per minute. Further information on request.

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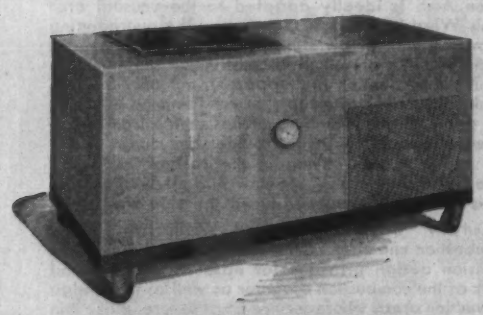
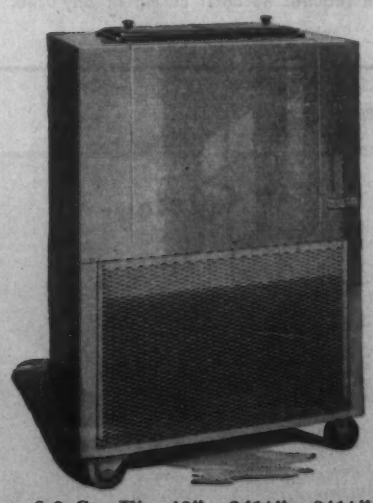


5.4 Cu. Ft. 32" x 34⅞" x 63½"



2.0 Cu. Ft. 48" x 24⅛" x 34⅛"

Forced aging of metals is one of American Industry's major production victories. . . . Maintaining cold temperatures for quick-aging metals, securing expansion fits and storing materials, is one of KOLD-Hold's contributions to modern high-speed production.

Kold-Hold's Industrial Sub-Zero machines are so flexible that the exact number of possible applications is not known.

But we DO know that these Kold-Hold units perform with high efficiency. They are sturdy, compact, self-contained, cold processing units.

If cold temperature is what YOU need — write for authoritative processing information.

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KOLD-HOLD MANUFACTURING CO.
436 N. Grand Avenue LANSING, MICHIGAN

from slabs 10 ft. wide by 25 ft. long, 25 in. thick in the main body, with thicknesses of 42 in. on the flange end. A cut through 51 in. of an alloy ingot is described, as well as production cutting of 32 in. alloy ingots using a stationary single purpose machine.

Although there is still much to be learned concerning the technique and perfected procedure for heavy cutting, it will be evident from the examples illustrated in this paper that this important phase of machine gas cutting is now acceptable as a production operation on thicknesses up to 42 in. without the employment of a lance.

In brief summary it is shown that the essentials for successful heavy cutting are: adequate oxygen and fuel gas supply; torches with sufficiently large orifices to provide ample preheat and cutting oxygen flow; sufficiently heavy machines of wide gage to provide for carrying heavy torch equipment at a slow and constant speed; carefully trained operators, who are methodical and exact in their workmanship; and, finally, perfection in technique and procedure.

—R. L. Deily & E. Benyo. Paper, Am. Welding Soc., October 1943 meeting.

Machining Lubricants

Condensed from "Tool Engineer"

Since the life of cutting tools depends upon their resistance to tempering effects, the selection of a suitable cutting oil is determined by factors producing this heat, namely, cutting pressures, rubbing speeds, and coefficient of friction.

Cutting pressures exerted on the tool comprise (1) lip pressure, which varies from minimum to maximum; (2) radial pressure at the nose or tip of tool due to variable lip pressure and lack of tool rigidity; and (3) feed pressure against the cutting edge, due to its rate of speed.

The function of a cutting oil is to minimize heat developed in several areas of the cutting tool by minimizing friction, and by localizing rubbing action of the chip away from the cutting edge by maintaining an adequate build-up. However, excessive build-up can be detrimental, since excess, instead of sloughing with the chip, is squeezed between the tool and the work piece, producing a roughened finish.

In a machining operation the best method of applying the lubricant is by directing a large volume of oil on to the upper surface of the chip and tool, in order to keep the chip and tool cool. In addition, a second stream should be introduced, if possible, into the boundary area of the tool. In grinding, the best results are secured by directing a high pressure jet into the pressure area between wheel and work.

In order to select a correct oil for a job the following information is necessary: Type of metal, condition of metal, and operating conditions. If this information is utilized the chips will be bright, with no smoking at the cutting tool, and parts will be only moderately warm. If tools do not perform satisfactorily, it must not be assumed immediately that oil itself is at fault. Actually, the trouble may be a mechanical one.

In heat treating aluminum alloy parts "L" Nickel resists corrosion and oxidation by Sodium Nitrate at 980° F.

Fused sodium nitrate baths . . . used for heat treating duralumin fighter plane parts rapidly, uniformly and without oxidation . . . are heated to and held at 980°F. continuously by immersion-type electric heaters.

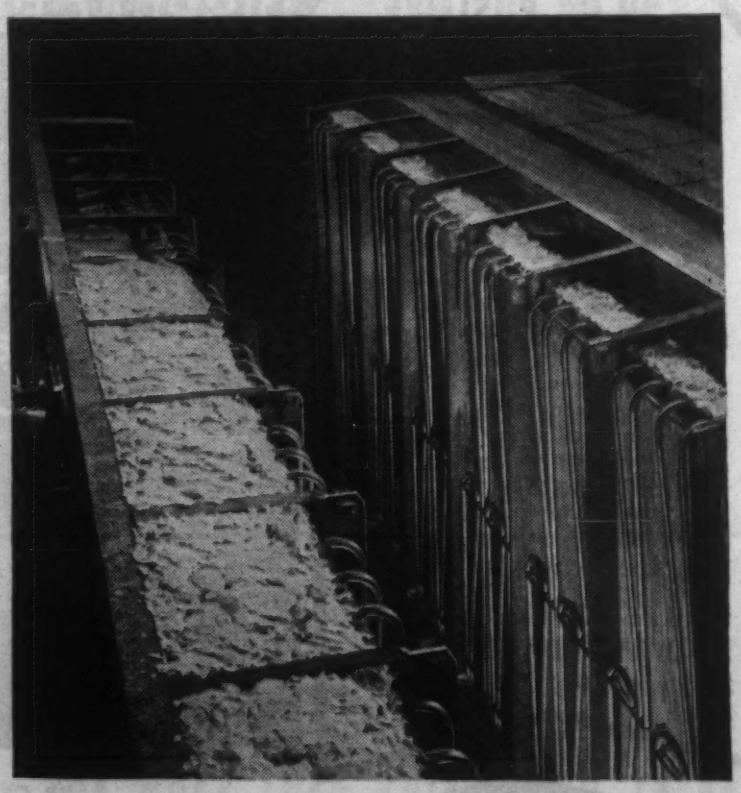
The sheathing of the heaters, immersed in the molten sodium nitrate, encounters highly corrosive action.

Carbon-free "L" Nickel resists corrosion and embrittlement by these molten salts. It also retains good mechanical properties at operative temperatures.

You may have a problem that is entirely different. But whatever special characteristics you need in a metal, you are invited to call upon INCO's Technical Service for information and data. You, too, may find that an INCO Nickel Alloy will solve your problem.

*The details of this use of carbon-free "L" Nickel are published in the belief that they will be of interest and value to engineers and designers working on similar problems, though the use of "L" Nickel today is restricted to approved applications.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET NEW YORK 5, N. Y.



Close-up of "L" Nickel-sheathed immersion heaters that hold sodium-nitrate at 980° F. for use in heat-treating duralumin parts for fighting planes.

★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL

Sheet...Strip...Rod...Tubing...Wire...Castings

Protect your work with

BLACK-MAGIC

"the one bath process"

A *QUICK* cheap finish for steel.

Black-Magic is approved on all contracts calling for "black oxide", "alkali black" or "chemical black."

Black-Magic has worked three shifts on War work in many high ranking plants for three years or more, without breakdown. "1,600,000 machine gun magazines without a rejection" says one superintendent.

We guarantee satisfactory production and maintain service free of cost.

Other black oxide processes for Brass, Copper and Zinc.

WITCH-DIP—a rust resistant final finish.

SILCO—the latest name in protective coatings. Rust, abrasion, impact and acid-proof.

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"R-C" POSITIVE DISPLACEMENT BLOWERS

—will handle more air per horsepower, and with less upkeep, than any other type of blower.

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For the duration, Roots-Connersville production is dedicated to the job of "making it hot for the axis." Even though war restrictions may defer your procurement of new equipment for plant improvements, we will be glad to help you work out the details of your needs now — for future action. *Planning now* will save time, later. Write for bulletin.

ROOTS - CONNERSVILLE BLOWER CORPORATION

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POSITIVE DISPLACEMENT moves more air • MODERATE SPEED means less wear

"R-C" Rotary Positive Cupola Blower installed in a mid-Western foundry. Capacity 2,700 CFM; 20 oz. pressure; 484 RPM.

Roots CONNERSVILLE SINCE 1854 Positive Displacement CUPOLA BLOWERS

Cutting tool angles depend on speeds, feeds, type of tools, and cutting qualities of metals. Generally sharper rakes are used in machining draggy metals. Too sharp a rake may leave edges unprotected, and result in short tool life. Cutting surfaces of tools should be as smooth as possible to minimize friction. After grinding, the surfaces of tools should be stoned.

Contamination of the cutting oil with oil in the bearing lubrication system usually changes the viscosity of the cutting oil, dilutes pressure resisting and lubricity ingredients, and may introduce additional lubricity into cutting oils.

If the proper oil is selected, wear in cutting tools will appear in the form of a crater back of the cutting edges. At the same time the finish will be satisfactory, and wear on the lip will be gradual.

When the desired crater is obtained, but life of the tools is short, excessive friction between chip and tool is indicated.

J. T. Beard, *Tool Engineer*, Vol. 12, Aug. 1943, pp. 69-73.

New Phosphate Coatings

Condensed from an Electrochemical Society Paper

The phosphating of certain metals, to increase the adhesion of the supplementary organic coating, has been used for centuries. Started probably in the third century, A.D., by the Romans, Coslett's patents in 1908 and the Parker Company's work developed the modern processes, generally known as "bonderizing" or "parkerizing." The time required for treatment has been greatly reduced by addition of small amounts of various chemicals, as manganese di-hydrogen phosphate, copper salts, and alkali nitrates and nitrites, to the bath.

The "wiping effect," in which the structure of the phosphate coating is improved by wiping the zinc-plated steel surfaces just prior to immersion, was covered by the Allen patents. Structure improvement was obtained also by the use of a predip, preferable for small or irregular work.

Disodium phosphate gave excellent results when used for predipping, with fine grained, uniform deposits resulting. However, it was discovered that some batches of the chemical gave god results while others did not, and titanium was finally isolated as the activating agent. This led to the development of the titanium disodium phosphate predip.

As finally worked out, the pre-dipping solution is 0.5 to 1 per cent disodium phosphate, to which a soluble titanium salt has been added. The latter compound is present in only about 0.01 per cent of the concentration of the disodium phosphate. Correct proportions of the sodium and titanium compounds are combined in the original solution and evaporated to dryness before making up the dipping bath. The predip then remains active for weeks at a time, even under heavy production schedules.

The finish obtained on either steel or zinc, with the commercial phosphate treatment following this predip, is unusually smooth and fine grained. A single coat of lacquer may be applied without a rubdown, and for many applications the organic coat may be dispensed with alto-

"SWESCO"—The Melting Pot of the Magnesium Industry!

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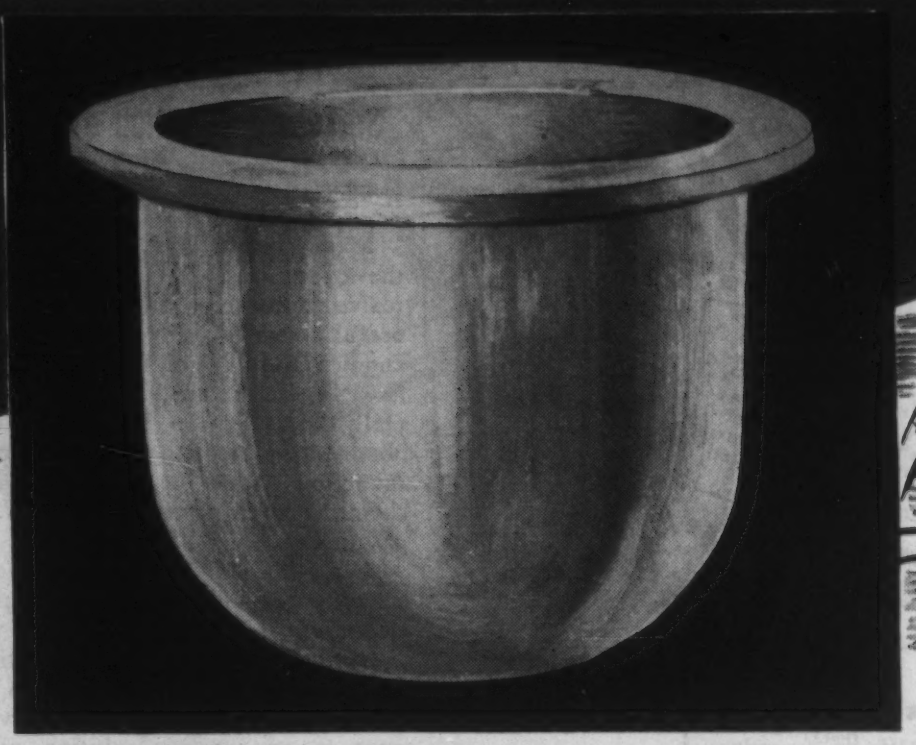
PRODUCED BY MASS PRODUCTION IN WEIGHTS FROM 50 to 7500 POUNDS

• Any Size Or Design



WE were well prepared for the coming of the Light Metal Age! For 32 years manufacturers of cast steel melting pots and steel and alloy castings, it was natural for the new Magnesium Industry to look to us for aid in solving many of its problems.

"SWESCO" Cast Steel Melting Pots were specially designed for the Magnesium Industry in size, design, chemical and physical analyses. They have also proved highly satisfactory for cyanide, lead and salt baths. Today, "SWESCO" Cast Steel Melting Pots are being used by leading magnesium smelters, die casters, foundries and incendiary bomb manufacturers. For more detailed information phone, write or wire Dept. SCS-5834 today.

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It is our "know-how", born of more than a quarter of a century of experience, that is making a vital contribution towards the speedy defeat of the Axis! The Gun Mount Pedestal and Tank Hub illustrated here are but a few of the many important contributions that we are making for Victory!

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OF BETTER SILVER ALLOY BRAZING

WITH SCAIFLUX 21

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Propeller-Blade Manufacturer. Finds through exacting tests that Scaiflux 21 definitely improves shear and tensile values of brazed joints.

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CASE 4
Aircraft Parts Manufacturer. Reports that extensive tests on various brazing operations prove Scaiflux 21 most satisfactory on all counts.

Users are enthusiastic about Scaiflux 21. Brazing craftsmen prefer its effective quick action. Check the comments from manufacturers who are using Scaiflux 21. They tell the story—give you the definite proof of the superiority of this faster, simpler, silver alloy brazing flux.

Descriptive bulletins on request.

**Details on request*

SCAIFE COMPANY
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gether. Processing times and temperatures for the phosphating treatment were also reduced.

It was found to be possible to meet the Navy 200-hr. salt-spray specification with one coat of air-dry lacquer over the phosphate finish on 0.0003-in. zinc plate on steel. Corrosion resistance was proportionately increased on plain steel. The only serious limitation to this type of coating is that the plain phosphate coating over zinc plate has a relatively high electrical resistance, which may be either an advantage or a disadvantage.

—George Jernstedt. Electrochemical Society, Preprint No. 83-30, April 1943 meeting

Surface Protection of Magnesium

Condensed from "Canadian Metals & Met. Industries"

Magnesium alloys intended for use in the open must be protected against corrosive influences if they are to give a useful service life. Several valuable anodic and chemical dipping processes have been developed in consequence. Generally speaking the best results are to be obtained by resorting to a duplex process involving either a chemical or electrochemical pretreatment followed by spray painting.

A preliminary survey was made of the behavior of metallic magnesium under electrolytic treatment in a wide variety of aqueous electrolytes. The protection of the two commercial alloys, AM503 and A8 was considered. A process involving treatment in an aqueous solution of chromic acid using either a.c. or d.c. superimposed on a.c. was developed and studied. The degree of protection is estimated by means of corrosion tests. Three tests adopted are: Continuous immersion, intermittent and salt spray.

Electrolytic methods employing various acid and salt baths afford little protection. Apart from chromic acid, no other acid solution produces a coherent film on magnesium. The alloy AM503, but but neither metallic magnesium nor the alloy A8 can be effectively protected against corrosion by a.c. treatment on hot 5 per cent chromic acid. The excellent results obtained are attributable primarily to the low magnesium oxide content of the film which consists chiefly of a mixture of the oxides of chromium and manganese. Such films have a compact structure and when fully developed are able to suppress the oxidation of the magnesium and probably also of the manganese. Their further growth is largely due to deposited oxides of chromium. The absence of these oxides in the films produced by d.c. explains the failure of the anodic process to produce equally satisfactory results.

The alloy AM503 can be effectively protected by treatment in hot, dilute chromic acid either with a.c. alone, or preferably with a.c. plus d.c., whereas A8 cannot be so protected and neither AM503 nor A8 can be protected by d.c. irrespective of whether they are treated anodically or cathodically.

—N. Parkinson & J. W. Cuthbertson. *Can. Metals & Met. Inds.*, Vol. 6, Aug. 1943, pp. 33-36, 40.

Furnace Completely Purged...

The sensitive indicator of the Ranarex* instrument shows exactly when furnace is purged. Just measure specific gravity of your generator gas and continue purge until specific gravity is the same at the furnace outlet as it is at the inlet. Then you know there's no air in the gas. Danger of explosion is reduced, need for safety margin of purging time is eliminated.

Ranarex helps maintain quality of heat-treated metals, too. It's a sturdy instrument, containing no chemicals or fragile parts. Anyone can operate it.

Write for a free bulletin to The Permutit Co., Dept. A17, 330 West 42nd Street, New York 18, N. Y. In Canada: Permutit Company of Canada, Ltd., Montreal.

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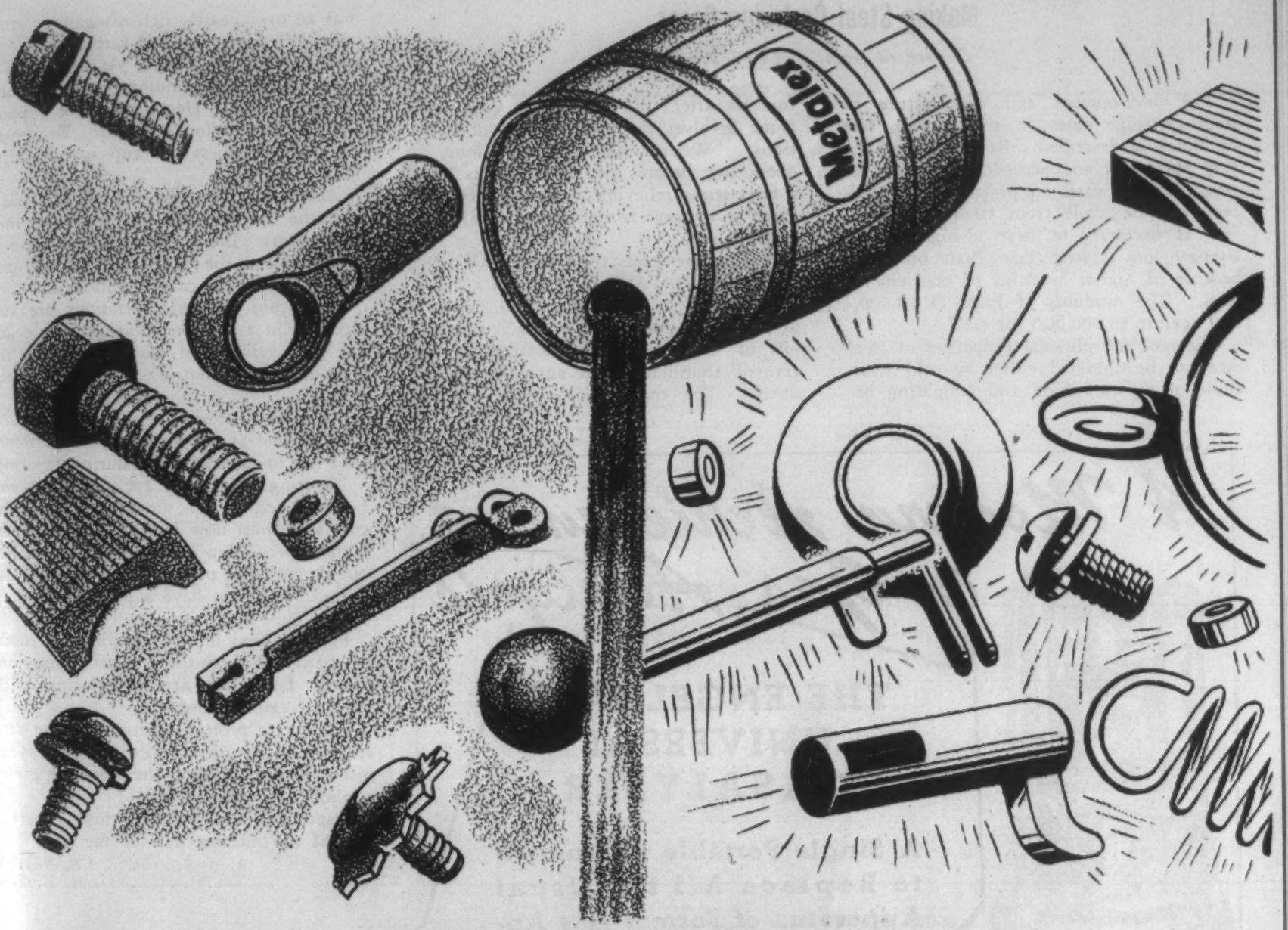

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FASTER ACTING -
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The only way to truly appreciate the remarkable cleaning qualities of this superior compound is to try it in your own plant. You'll be amazed at the saving you can make in time, money and materials — at the ease in removing the stubbornest of dirts or greases — at the quality of your METALEX cleaned products . . . Have a MAC DERMID Inc. representative demonstrate — prove by test in your own plant — the superiority of METALEX. Ask him about the many other MAC DERMID Inc. compounds that have been developed in answer to today's speeded up war production.

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Making Steel Cartridge Cases

Condensed from "S.A.E. Journal"

The development and manufacture of steel cartridge cases in the 75-mm. size by Buick is described. Results have been very successful and according to latest report cartridge cases in practically all calibers will be made from steel.

It is necessary to have a higher yield strength on a steel case than on brass because of higher modulus of elasticity of steel. The modulus of brass is 14,000,000 against 30,000,000 for steel.

The required physical properties of steel case can be obtained either by cold work alone or by quenching and tempering before or after cold working. Cold work alone involves the least number of operations. Where cold working alone, or quenching before cold working, is used, a final stress relieving treatment should be given to improve further the physical properties.

Among the steels tried were SAE 1015, 1016 and 1020, AISI C-1019, and a higher manganese type containing 0.20 per cent C, and 1.29 per cent Mn. Experimental lots of C-1019 included coarse and fine grained aluminum-killed and silicon-killed steels. The composition finally adopted was an open-hearth high manganese, aluminum-killed, fine grained carbon steel.

For a 75-mm. case a 3⅛ in. blank is used. Centerless grinding provides a more perfect surface. Heating for hot cupping is by induction for 1½ min. To control the wall thickness the cup is cold sized in a press.

After annealing, acid pickling and washing, the head of the cup is coined in a crank press. Bonderite treatments serve to clean and etch the case. To avoid hydrogen embrittlement the case is annealed.

Four cold drawing operations are carried out in a 750-ton Clearing double acting press. Depth of draw varies over the four dies, being controlled by length of the punch.

Annealing before tapering is important. It is limited at the mouth end to a depth of 2 in. to prevent splits during tapering.

Tapering operations are the most important, because in these operations the cold steel must flow into the desired taper, without wrinkling or distortion and without support of a punch on the inside. The second stage does have a punch extending 3½ in. into the case.

Punches used in cold drawing are made of hardened high-speed steel chromium plated. Lower dies are or steel rings with tungsten carbide inserts.

Coating to protect against corrosion and sparking is an unpigmented phenolic varnish. Before painting, the cases are given a phosphoric acid pickle.

Inspection tool permits close observation of the interior wall of the case.

—R. B. Schenck, *S.A.E. Journal*, Vol. 51, July 1943, pp. 229-233.

A Modern Achievement in Gas Analysis

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Heat Treatment of Alloy Cast Iron

Condensed from "Foundry"

Hardness increase of 150 to 300 Brinell is obtainable by heat treatment, and the higher value usually accompanies the cast iron which was initially harder in the as-cast condition. Quenching temperatures used on most irons at the present time are 1450 to 1600 deg. F. Oil is the most common quench medium.

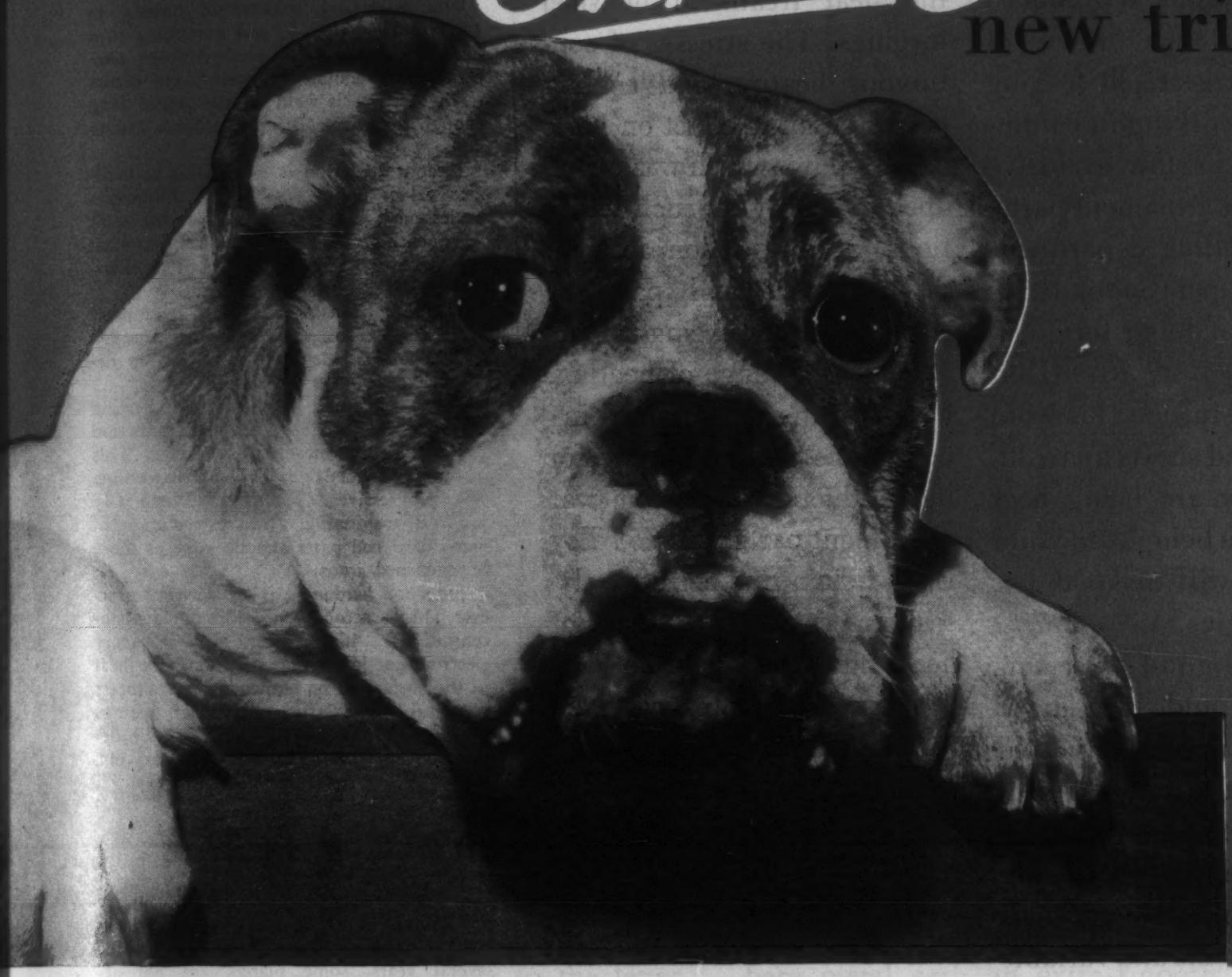
Castings may be annealed completely or partially and softened for machining, before hardening them, without affecting the subsequent response to hardening. This is due to the rapid re-absorption of graphite in solution at temperatures above critical. Castings to be hardened usually are rough-machined and finished by grinding. A small amount of distortion occurs on quenching, and allowance must be made for this in leaving stock for finish grinding.

For castings of complicated shapes it is desirable to apply the milder quenching to avoid cracking or excessive distortion. Appropriate amounts of Ni, Mn, Cr, and Mo reduce the rate of transformation so that the end structure after cooling in the mold or in air, will approach structures produced in unalloyed iron by oil or water quenching.

Heavy castings usually are made of low-Si, low-C irons alloyed with Ni, Cr, Mo and possibly V, all in proper balance, so that carbide colonies are not formed or other undesirable ingredients introduced.

As to the hardening effect of an air quench, castings are heated above the criti-

You can't teach an *Old Dog* new tricks



So says the proverb!

Yet, almost overnight, American shipbuilders—"old dogs" at their business—*learned* the entirely "new trick" of constructing steel cargo vessels and war vessels by welding. If they hadn't, the "bridge of ships" that made the conquest of North Africa and the invasion of Europe possible would still be just a pipe dream.

Contributing much to the shipbuilding industry's phenomenal production records is the "researched line" of **McKay Welding Electrodes,** a preponderance of which now goes into all-welded ship construction.

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Amsco Alloy Furnace Parts Give "3-Shift" Service in Forge Shop

The photographs reproduced below were taken in one of America's largest job forging shops, now working in continuous shifts in the exclusive production of armament parts. The heat treating department is in 24-hour operation and handles plenty of huge forgings.

This company installed Amsco Alloy furnace bucks to support forged shafts up to 30′ long, as they are being heat treated before being made into units which will make it hot for our enemies. View R-799 shows the design of these furnace bucks, and the larger illustration shows them spaced crosswise on a furnace car bed.

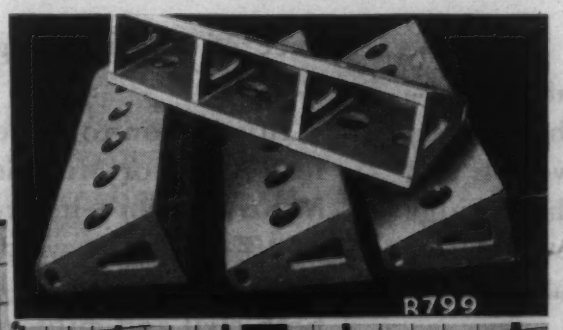
Amsco Alloy was chosen because of its demonstrated ability to stand up for long periods under the extreme and variable temperatures encountered in the heat treatment of steel forgings. The stresses of continuous heating and cooling have minimum effect on parts of this alloy, which was developed expressly for such conditions, and oxidation as well.

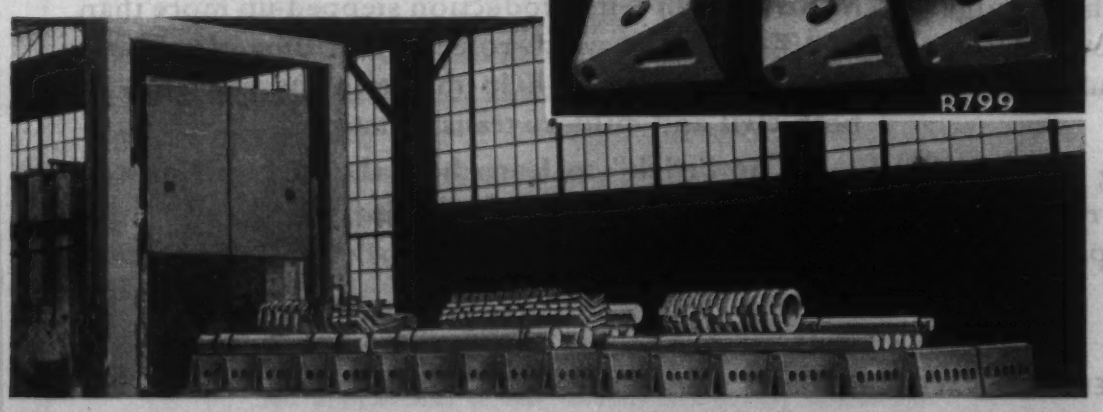
Equipment and parts of Amsco Alloy are being used in all the wide range of heating, heat treating and carburizing operations utilized today for the production of essential war equipment parts. Amsco Alloy is made in a number of analyses to meet varying degrees of heat and corrosion, or both.

Amsco engineers have given valuable assistance to the war industries by designing castings for specific requirements, frequently enabling ready conversion of existing equipment.

Bulletin 108 on Amsco Alloy will be mailed on request.

Illustration shows car type furnace in midwest forge plant where bucks (R799) are used to support heavy shafts and forgings during heat treating cycle.





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cal temperature, 1450 to 1550 deg. F. held long enough to acquire heat uniformly, then cooled in still air. Under controlled conditions, air hardening may be practiced by interrupting the cooling in the mold, after solidification, and applying a carefully timed shake-out.

Hot quenching consists of heating to 1400 to 1600 deg. F. and quenching in a hot liquid held at a predetermined temperature. Pronounced improvement occurs if the casting is held in the liquid long enough to achieve Brinell hardness 250 to 400.

Heat treated iron is machinable at hardness values up to 300 Brinell. Distortion is lessened, and dangers associated with the quenching of complicated shapes which are liable to fracture are reduced considerably.

Nitriding consists of heat treatment, after which castings are heated in nitrogen at 950 to 1000 deg. F. for 60 hrs. to develop a case 0.010 to 0.015 in. deep.

Flame hardening is a process of heating the surface layer above the transformation temperature by means of a flame. This method is divided into (1) spot hardening, (2) progressive, (3) spinning, and (4) progressive-spinning. Microstructures of flame hardened parts are the same as those of quenched irons.

Induction hardening is an electrical process. This is accomplished through the concentration of high power, high frequency electromagnetic current generating the heat in the surface to be hardened. This process is useful where large volumes of castings must be treated to compensate for the development of suitable jigs, fixtures, etc.

—J. S. Vanick, *Foundry*, Vol. 71, Aug. 1943, pp. 96-97, 176-179.

Plating-Rack Insulations

Condensed from "Metal Finishing"

Although synthetic resin plating insulations have been successfully used for several years, some platers are not acquainted with the advantages of this type of insulation. Materials that are suitable for use in different plating solutions and under varying conditions are available. All of them may be applied by either brushing, dipping, or spraying.

Plating racks may be readily insulated in the plating shop if a few simple directions are followed. About six coats of insulation are usually recommended. Drying time is one to two hrs. Forced drying at 150-225 deg. F. may usually be used.

A very long-lived and serviceable rack insulation may be made by applying two coats of resin, followed by wrapping with ½-in. cotton twill tape. A tacky undercoat gives adhesion of the tape. Four coats of resin are then applied over the tape, allowing six to eight hrs. after the last coat before the rack is put into service.

Racks should have rounded corners and edges, since a suitable film thickness cannot be built up on sharp corners or edges.

Breaks in the insulation, or ragged edges at contact points, can be readily repaired by brushing on some of the synthetic resin solution.

—Jack McGee. *Metal Finishing*, Vol. 41, 1943, pp. 138-139.

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Aluminum After the War

Condensed from "The Engineer"

Aluminum promises to play a leading part in the progress of light alloy engineering after the war. The present price of aluminum in England is £16 (about $64.50) per ton above the pre-war level, and in the United States it has been reduced 25 per cent since Sept., 1939. During 1942 the Aluminum Company of America produced 1,000,000,000 lbs., or 63 per cent more than the world output in 1938. Manufacturing facilities have kept pace with the production of the metal. By the end of 1943 it is anticipated that the United States will produce approximately 6½ times the production in 1939, or about 900,000 tons.

From the economic standpoint, the strength-weight ratio is of vital importance in aircraft, and in any moving machinery where reduction of dead load means a corresponding reduction in power demand. An ultimate tensile strength in excess of 30 tons per sq. in. is usual in heat-treated aluminum alloys, with the result that they can compete with alternative materials in so far as mechanical strength is concerned.

After the war we may see the use of aluminum alloys on a large scale in the construction of long-span bridges. A bridge requires at least 5/6th of its strength to support its own weight, thus leaving less than 20 per cent free for carrying the load. Heat-treated aluminum alloys can carry greater loads per unit of their own weight than any other material with correspondingly greater structural rigidity.

As to welding of aluminum, the Philips spot welder, type E1500, has been designed specifically for welding of aluminum in thicknesses varying from two sheets of 22-gage material to two sheets of 10-gage material. A special Metrovick aircraft-type spot welding machine is equipped with ignitron control, which permits a high initial current to effect the weld, followed by reduced current to give it appropriate heat treatment. A useful feature is a device for increasing the pressure at any stage in the welding cycle.

Progress has been made in recent years in application of electric arc welding to aluminum alloys. It is generally possible to use this process in any position except with the work vertical. Welding is generally carried out from one side only, although in case of thick plates, when the carbon arc is used, welding is done from each side.

The electrode core wire generally consists of 5 or 12 per cent silicon alloy, and electrode length varies from 14 in. to 18 in., the minimum diameter being 12 s.w.g.

An example of a welded aluminum structure is a three-coach articulated passenger unit in France, constructed in 1933. The complete unit weighs 75 tons and is designed to carry 534 passengers. This compares with steel cars, each of which weighs 43 tons and has a passenger capacity of 118.

Another example is provided by the aluminum alloy booms of large excavators. Reduced weight of boom permits use of a longer boom without reduction in cubic capacity. In the field of post-war aviation larger engines will require larger propellers,

What every engineer should know about impact tests of plastics

THE growing use of plastics in important engineering applications has led to a growing emphasis on impact strength—and to more than a little confusion on the part of those used to dealing with strength data on metals and other materials. To help clear up this confusion, here are a few simple facts about methods used to determine and express impact strength of plastics.

Two different tests are common—the Charpy and Izod. A.S.T.M. at present favors the Izod and this is the method used by Monsanto.

HOW TESTS ARE MADE

In both methods, a test specimen is fastened in the path of a pendulum. The pendulum is swung, breaking the specimen, and the angle through which it swings is then read from a calibrated dial. This value, subtracted from the angle through which the same pendulum swings *without* an obstruction in its path, gives a measurement of the amount of energy required to break the test specimen and hence, of the specimen's ultimate impact strength.

In both methods, the test specimen is obtained from a solid, rectangular bar, 5″ x ½″ x ½″, molded under specified conditions.

In the Izod method, however, this bar is cut exactly in half and the two halves notched at their centers. It is then held *vertically* at one end in a clamp and the blow is struck *on the notched face* at a carefully specified point close to the notch.

In the Charpy method, the entire 5″ bar is used. It is notched at its center and is supported in a *horizontal* position at two points ½″ from each end. The piece is struck *on the side opposite* the notch. Values obtained by this method average higher than those determined by the Izod test.

HOW RESULTS ARE EXPRESSED

Impact strength as determined by either Charpy or Izod methods is reported in three different ways:

1. *Foot-pounds energy to break*, the only value determined directly in the test.
2. *Foot-pounds per inch of notch*, obtained by dividing the value above by the width of the specimen.
3. *Foot-pounds per inch square*, obtained by dividing the foot-pounds energy to break by the cross section area below the notch.

As an illustration of the wide difference in figures for impact strength which results from these differences in reporting, the impact strengths of two representative Resinox phenolic molding compounds are reported below in all three ways:

IMPACT STRENGTH	RESINOX 4216 (A general purpose compound)	RESINOX 6952 (A high impact compound)
Ft.-lbs. energy to break	0.13 - 0.14	3.2 - 4.0
Ft.-lbs. per inch of notch	0.26 - 0.28	6.4 - 8.0
Ft.-lbs. per inch square	1.63 - 1.6	40 - 50

Obviously, the most important points for an engineer to remember in evaluating plastics for their impact strength is this: *be sure that the test methods used and the units in which results are reported are comparable.*

HOW TO GET MORE FACTS

As one of the nation's largest manufacturers of plastics, Monsanto is interested in helping engineers get the facts on these relatively new and highly promising engineering materials. For further information on the versatile family of Monsanto Plastics, one of the broadest and most diversified group of plastics offered by any one manufacturer, write for the 24-page book, "The Family of Monsanto Plastics, a Guide for Product Designers." MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

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and it has been claimed that hollow propeller blades of light alloy will be the solution. In the construction of large transport plane frames, great benefit should be derived from the use of taper gage and butted tubes. At present the maximum diameter that can be produced is 2½ in. and maximum length 20 ft.

Various applications of hiduminium anticorodal alloy are in transport enterprises. In the marine field an alloy known as birmabright has established a unique reputation, more particularly in the construction of lifeboats. Another example of this alloy is provided by a number of patrol cruisers.

—Rolt. T. Hammond. *Engineer*, Vol. 176, July 2, 1943, pp. 15-16; July 9, pp.. 33-35; July 23, pp. 66-68; July 30, 1943, pp. 94-96.

Plastics and Industrial Design

Condensed from "J. of the Royal Soc. Arts"

Plastics are defined as chemically produced materials which possess plasticity and may be shaped by the application of heat and pressure. From the introduction of the first plastic in 1862 until about 1935, plastics masqueraded as wood, metal, leather or glass, for industry in the past has often feared and rejected originality but has welcomed imitation. The new gifts of lightness, translucency, transparency, and the infinity of shapes, textures, and color were not used.

There is considerable danger that the frequent conception that plastics can do anything will lead to widespread misuse which will discredit plastics. Another danger of this intemperate enthusiasm is the assumption that the extensive use of plastics will automatically make familiar materials a back number. For example, the idea that plastics will replace glass is about as sensible as to say that trousers will replace coats. These people still think of plastics as substitutes.

Many materials have complementary uses. Productive partnerships are not only possible but almost inevitable, *i.e.*, plastics and plywood, plastics and aluminum, plastics and cast iron.

Frequent questions as to how cheaply plastics can be produced show a fundamental lack of appreciation of the potency of good design. Good design forms a broad bridge between raw materials and consumer needs; the excellence of the bridge will increase the volume of traffic.

Plastics will give the designer a limitless control of material hitherto attained only by enormous expenditure of time and labor. The world is now enduring a compulsory utility period. Before that functionalism had been preached with puritanical intolerance by many designers. Since love of ornaments is an old human characteristic, we may find the consuming public ready for an orgy of ornamentation after the war. Plastics could be used to create a new rococo period.

As a result of the uprooting of thousands of men and women during the war and their contact with well designed and

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All-important in the defense of our Navy's ships against attack by enemy dive bombers and torpedo planes is the 20-mm anti-aircraft gun. All-important to these guns themselves are the gun barrel forgings which Standard produces. At Standard, only acid open-hearth steel, rigidly controlled through every phase of manufacture, is used in making these forgings. The result—finished forgings with the high physical properties and high quality demanded by Navy specifications.

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efficient machines, the consuming public will be more critical after the war. Women will want new domestic equipment, light and easily cleaned.

We shall have every ingredient for a new renaissance of taste in this country: a receptive public, a galaxy of new materials, courageous and competent manufacturers, and some of the finest industrial designers in the world. We can avoid the dangers of misuse and vulgarization if we employ fully and freely the capacities of our industrial designers.

The development of plastics and their stimulating effect upon industrial design could accelerate our return to prosperity after the war.

—J. Gloag. *J. Royal Soc. Arts*, Vol. 91, July 23, 1943, pp. 462-468.

German Magnet Steels

Condensed from "Archiv Eisenhüttenwesen"

Literature is reviewed and experiments are described made to improve the magnetic properties of chromium steels and eventually to replace by these steels the magnet steel with 6 per cent tungsten. The practical conclusions can be summarized as follows:

By adding two or more alloying elements (and eventually by using a special melting process) steels with 3.5 to 4 per cent chromium can be made to have a magnetic capacity of about 350,000 gausses x oersteds. These improved chromium steels should have a demagnetization line that coincides entirely with that of the tungsten steel; they have a coercive power of 60 to 70 oersteds and a remanence of 9500 to 10500 gausses.

Steels with about 5.5 per cent chromium, have no better magnetic quality but a higher coercive power; a steel with 1.2 C and 5.5 per cent chromium had 75 to 85 oersteds and 8500 to 9500 gausses. It can replace the chromium-tungsten-cobalt magnet steel with 2 per cent chromium. The addition of tin, aluminum, vanadium, molybdenum and titanium are made to obtain special properties, which are shown in curves, and tend in general to reduce working and annealing sensitivity of the chromium steels.

—H. Krainer & F. Raidl. *Arch Eisenhüttenw.*, Vol. 16, Jan. 1943, pp. 253-260.

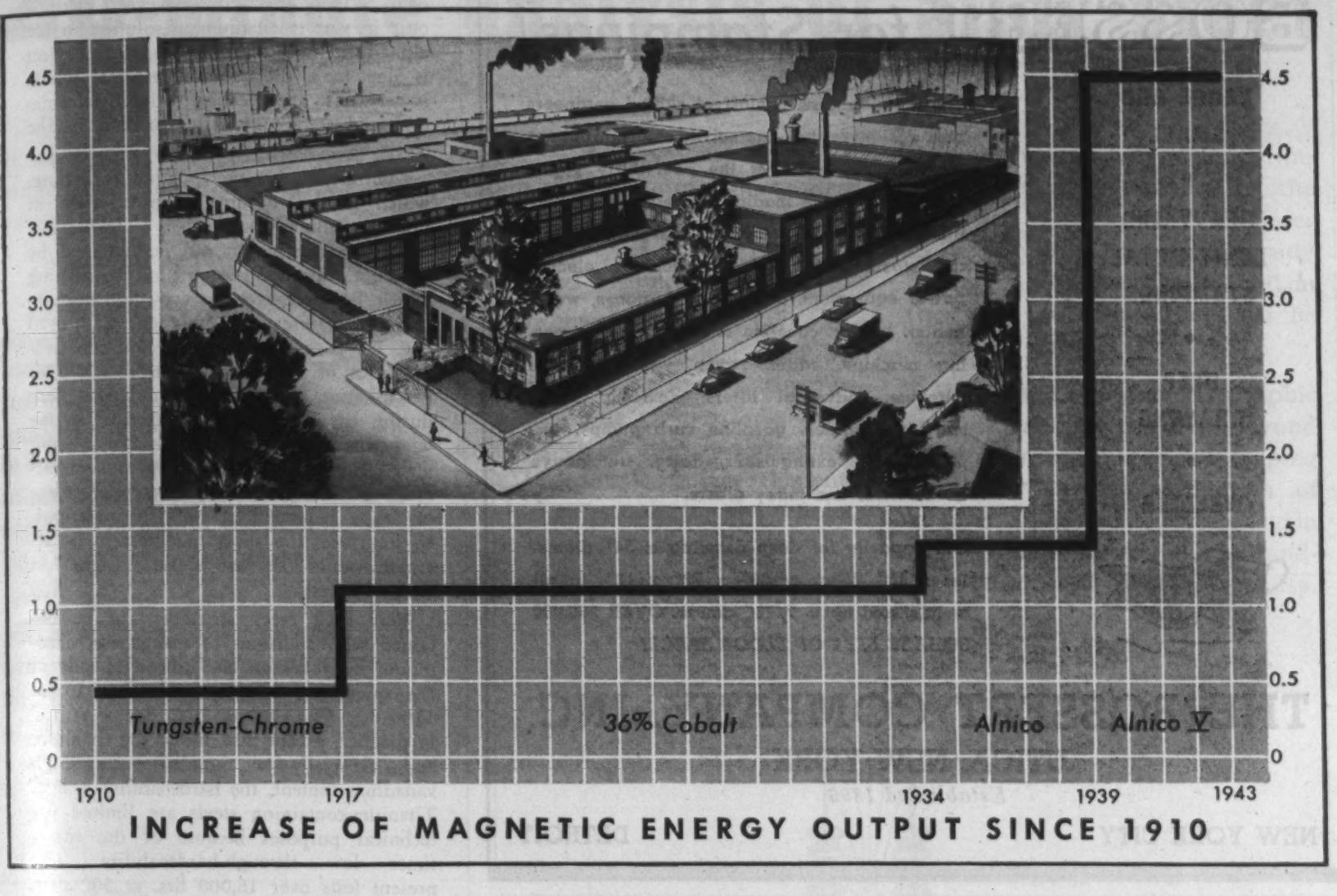
Creep Strength of Titanium Steels

Condensed from "Archiv Eisenhüttenwesen"

The effect of titanium content in low alloy titanium steels, of heat treatment, and of carbon, manganese, silicon, chromium, molybdenum and vanadium on creep strength was investigated for short and long-time test.

The creep strength of soft-annealed titanium steels at 400 to 600 deg. C. (750

PERMANENT MAGNETS MAY DO IT BETTER



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to 1110 deg. F.) increases with increasing titanium content (up to 2.8 per cent tested). This effect is, however, ascribed only in part to titanium in solution in the alpha-solid solution. The greater effect is due to a precipitation process, which is very slow at annealing without deformation and starts only after loading in the creep test.

Contrary to this precipitation hardening, which is due to iron titanide, even at lower titanium contents a considerably higher creep strength can be obtained by titanium carbide precipitation hardening which, however, requires very high quenching temperatures of 1300 deg. C. (2370 deg. F.) because of the high solution temperatures of the titanium carbides. This precipitation hardening does not take place during the creep test but already at the tempering temperature, which can amount up to 700 deg. C. (1290 deg. F.) on account of the great tempering permanence of steels hardened at high temperatures. In this case, the short time test gives accurate values that are a little higher in long-time tests.

Very high creep strengths can be obtained with additions of manganese, chromium, molybdenum and silicon already at the quenching temperatures of 1050 to 1100 deg. C. (1920 to 2010 deg. F.) used in practice, except that due to the titanium, and especially a simultaneously high vanadium content, the hardenability is lost. Titanium-containing steels are limited for technical purposes because of the sometimes low through-hardenability. The present tests over 16,000 hrs. at 500 deg. C. (930 deg. F.) therefore make possible savings of molybdenum and chromium by titanium in some types of heat resistant steels for certain purposes.

—E. Houdremont & G. Bandel. *Arch. Eisenhüttenw.*, Vol. 16, Sept. 1942, pp. 85-100.

Shear Strength of Aluminum Alloys

Condensed from "Aluminium"

Very carefully performed tests using a round punching die gave the following shearing strengths T_B-P_s/Ud in lbs. per sq. in. for various German aluminum alloy sheet materials, where P_s is the shearing force, U the circumference of the shearing die and d the thickness of the sheet.

Alloy Type	Shear Strength
Pure aluminum	10,100-12,800
"Purest" aluminum	10,100-12,800
Al-Mn	14,200-14,900
Al-Si	15,900-17,700
Al-Mg-Mn	23,400-26,800
Al-Mg	29,000-34,100
Al-Mg-Si	27,500-35,800
Al-Cu-Mg	26,300-41,400

In most cases, the upper values were obtained on precipitation-hardened alloys.

—H. Guth. *Aluminium*, Vol. 24, Oct. 1942, pp. 357-358.

20-minute analysis of alloy steel

It used to require many hours to make a complete quantitative analysis of a heat of alloy steel.

Today the picture has changed.

Using spectrographic methods developed by our engineers and metallurgists, Bethlehem can now run off a complete and accurate quantitative analysis in just 20 minutes. This analysis covers aluminum, tin, tungsten, molybdenum, copper, chromium, vanadium, silicon, nickel and manganese.

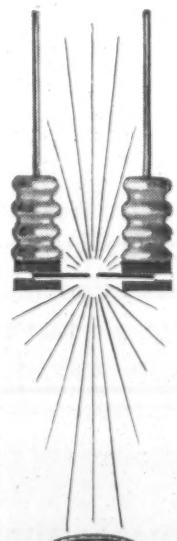
The idea of spectrographic analysis is not new. But the speed and accuracy of this technique *is* new, and has produced results which are of definite value to the war effort.

The first gain is a speed-up in alloy-steel production. Formerly, certain electric-furnace heats were considerably delayed due to waiting for analyses to be made by snail-paced chemical methods.

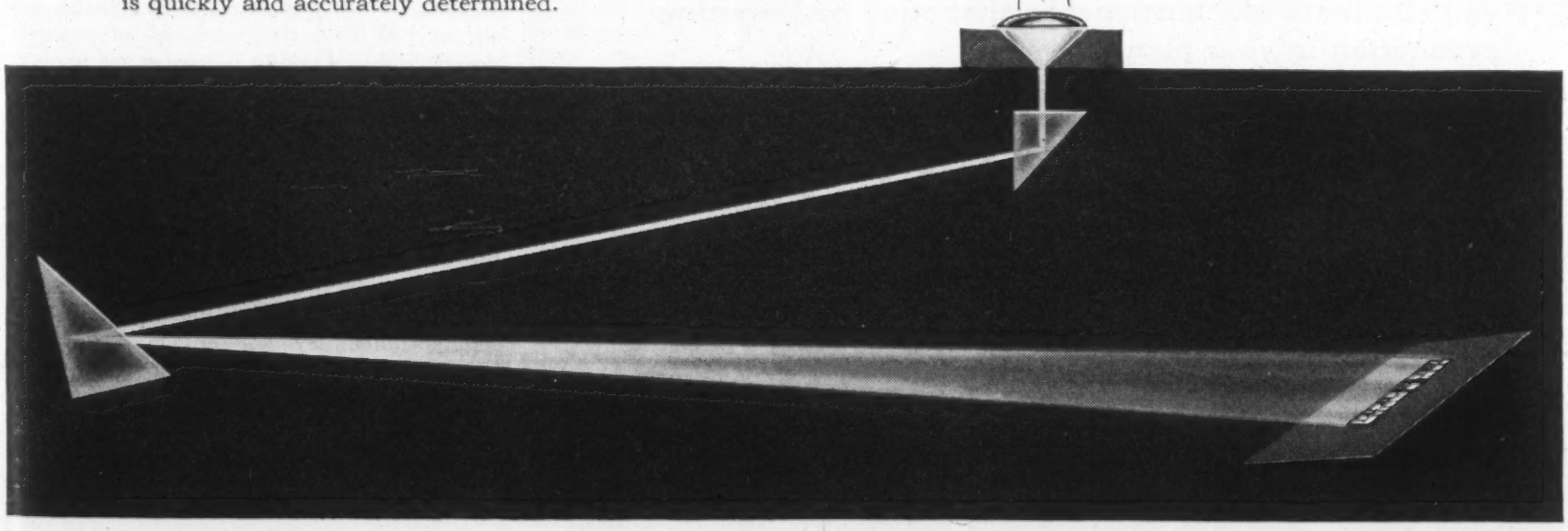
Now, however, we run two complete analyses—one just after the steel becomes molten in the furnace, and one at the ladle—plus as many as six intermediate quick tests to control certain elements which fluctuate during the refining of the heat.

The second gain due to spectrographic analysis is a definite improvement in the quality of the steel itself. Tests can be made closer to the time that the steel is ready for tapping into the ladle—and in this way the composition can be controlled more exactly.

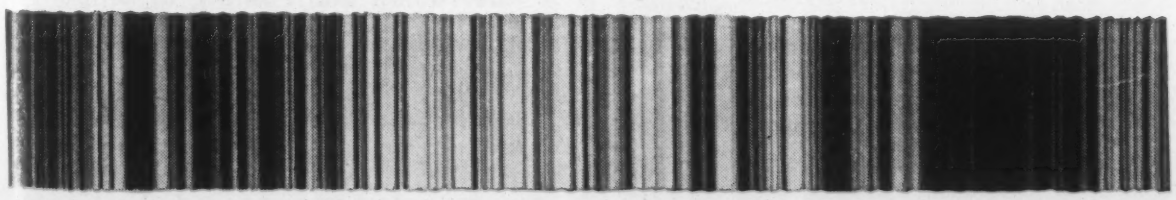
With Bethlehem, spectrographic analysis has progressed far beyond the experimental stage. It is helping materially in the production of larger tonnages of alloy steels, and in the advancement of quality standards. It is a hard-working actuality.



Here, in diagram, you see two small samples of alloy steel being tested. The samples serve as electrodes. A 33,000-volt current is passed between them . . . the spark is caught by a lens, directed through a slit, and passed through two prisms, diffracting the light into its spectral lines which are recorded on the photographic plate at the lower right. By interpreting this photograph, the composition of the steel is quickly and accurately determined.



This photograph portrays the spectrum of a typical sample of alloy steel. The vertical stripes represent various alloy elements and tell how much of each is present in the steel.



BETHLEHEM STEEL

British Cast Brasses

Condensed from "Foundry Trade Journal"

This is a joint report by the Institute of British Foundrymen, The Association of Bronze and Brass Founders, and the British Non-Ferrous Metals Research Association.

B.S. specifications for the cast brasses A and B were issued in the War Emergency B.S. specification 1021-1028: Copper Alloy Ingots for Castings, with a view to extending the use of these alloys for castings formerly made in gunmetal. These specifications are given at the right:

Cast Brasses A and B

	B.S.S. 1025-26	B.S.S. 1027-28
Cu %	70-80	62-70
Sn	0-2	0-2
Pb	1-4	1-4
Ni	0-1	0-1
Fe	0-0.75	0-75
Al	<0.01	0-0.25
Mn	——	0-0.25
Zn	Remainder	Remainder
U.T.S. tons per sq. in.	11	14
Elongation % on $4\sqrt{A}$	20	12

The Non-Ferrous Metals Control expressed their concern at the limited use of these materials and requested that an investigation be made to determine whether there were serious difficulties encountered in practice and to determine whether any modifications of the specifications were necessary or desirable.

Replies to the questionnaire indicate that brasses A and B can be satisfactorily used for small castings of thin section using technique formerly used for gunmetal. The brass A appears to be satisfactory for pressure castings. The use of a brass of high copper content near to the upper limit of the specification helps in obtaining pressure-tight castings.

Limitations Set

The presence of Al in brass A is harmful to both castings and mechanical properties. The general conclusion is that brass A is suitable for simple castings, *e.g.*, of thin and uniform section, but for more difficult castings with, for example, considerable changes in sectional thickness, it is desirable to use a brass with a copper content at the upper limit of the specification (80 per cent). The permissible working pressure of hydraulic fitting in brass A is limited by the foreword of the specification to 100 lbs. per sq. in. With certain castings of suitable design higher working pressures are permissible in this alloy, and it is suggested that this limitation is reconsidered.

Brass B is satisfactory for simple castings not required to withstand pressure. It is mainly used for thin section castings, and it is likely that for heavier sections the casting technique would have to approach that used for manganese bronze. It appears that alloys of the lowest permissible copper content (62 per cent) and with the maximum tin content (2 per cent) may contain large amounts of a brittle phase, with a resultant serious effect on the mechanical properties. It is suggested that the tin content of this brass should be limited to 1 per cent.

—*Foundry Trade J.*, Vol. 70, July 15, 1943, pp. 219-220, 224.

Corrosion and Fouling of Ships

Condensed from "Engineering"

Methods proposed for the suppression of corrosion and fouling have usually been based on the use of special alloys, electrical systems and paints and compositions. The Corrosion Committee of the Iron &

(Continued on page 1176)

Today's war of movement goes into even faster action as the 'round-the-clock allied air attacks soften up enemy-prepared positions, blast supply lines and wreck armament plants.

Here at Acme, we're also in action—24 hours a day. Every previous record in producing tools, patterns, and heat-treated aluminum castings has been broken. And new records have a very short life. For the faster we work, the more we help war production plants to deliver fighting tools on time.

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COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Copper Alloys in the Post-War Planning Picture

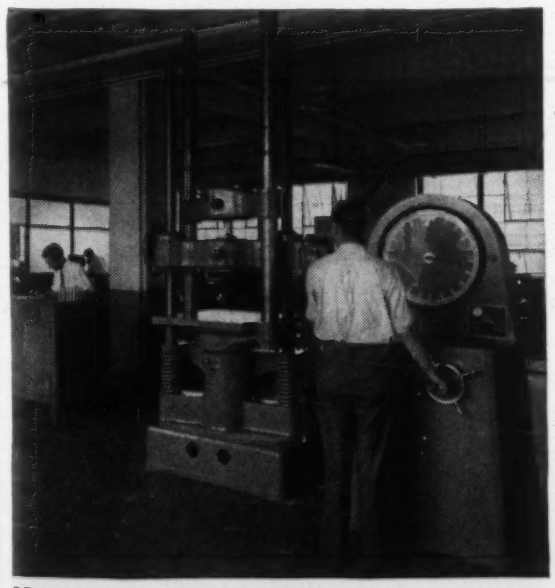
Many opportunities for new developments to be found in time proven alloys and new specialties

That industry is doing an outstanding job in war production has been recognized by all. Constantly stepped-up production schedules have been made possible by better manufacturing techniques, working machines around the clock seven days a week, and by greatly increasing the number of workers.

Just as industry is most anxious to serve in helping to win the war, it is just as anxious to do a fine job in times of peace. It realizes that a high employment rate at good wages means a ready and profitable market for consumer goods. How to maintain its present employment rate when peace comes is troubling many an industrialist.

New Peacetime Products Will Take Place of War Production

Post-war planning includes many problems. Those manufacturers who have temporarily set aside their peacetime lines are taking inventory as to necessary design changes and available equipment. Ultimately they look forward to quicker and cheaper methods of manufacture from the lessons learned from quantity production. Those who have invested capital in new machinery and are now making an entirely different line are hoping to salvage most of the equipment and to use their new knowledge by turning out new products in addition to their old lines.



New-product research will be able to draw upon the facilities of this fully equipped Physical Testing Laboratory at Bridgeport.

Military Needs Develop New Copper Base Alloys

Today the development engineer is in a most fortunate position. He has more to choose from—new copper-base alloys and higher quality brasses and bronzes. War has always had a profound influence on brass making. Munitions demand the best—impeccable quality, dependable uniformity, close tolerances, unbelievably high production. Conditions during this war are more rigorous than ever because of its mechanical nature. Fast operating guns and artillery use up untold quantities of ammunition, most of which is made from easily worked brass.

Techniques learned from the war and the modern equipment which has been installed for mass production will be available for peacetime use. Close control for producing uniformly high quality to meet exacting specifications has meant greater technical supervision and a more generous allotment for metallurgical research and the development of new copper alloys.

Workability, Strength and Corrosion Resistance of Copper Alloys

Copper-base alloys containing zinc, silicon, aluminum, tin, nickel, etc., possess a unique combination of physical properties seldom found in other alloys—easy workability, great mechanical strength, exceptionally fine corrosion resistance, capability of taking on attractive finishes. They stand repeated stresses without failure and they resist wear from abrasion. To meet specific conditions some alloys can be so modified that they will draw easier, machine more freely, or resist corrosion better. Such refinements lower the cost of production and increase quality.

Bridgeport's Laboratory Will Aid New Products Research

Much time can be saved by the design engineer who is working on his new product developments. Let him get in touch with one of our technical advisors for help in the selection of the available copper base materials. However, if his new product requires an alloy with special properties, now is the time to develop it. Put this problem before our Bridgeport Research Laboratory staff who are always glad to cooperate.

Memos on Brass—No. 42

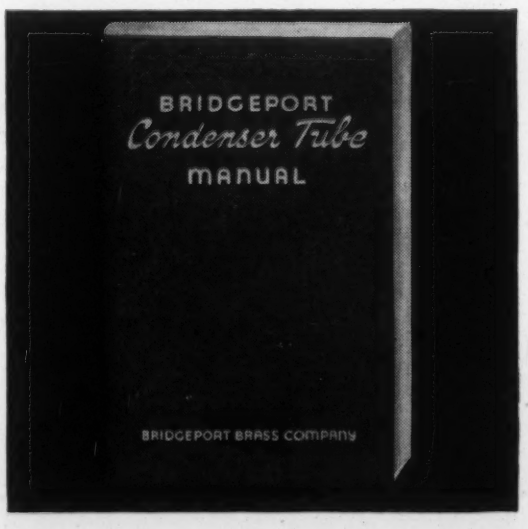
For making strong, precise and intricate articles at high speed, cold heading is the most economical method. Brass is admirably suited for this process because it has the necessary malleability and develops great strength during forming. Because each cold heading job presents a different problem, care must be taken in the selection of the proper alloy with the right stiffness, correct grain structure, uniformity and freedom from imperfections.

New Enlarged Edition of Condenser Tube Manual

The new edition of the Bridgeport Condenser Tube Manual, comprising over 112 pages profusely documented with 39 photographs, 29 diagrams and 23 tables of up-to-date information, is now ready for distribution after more than a year of careful preparation. The contents provide much new and heretofore unpublished information on copper alloys that should be of great help to engineers and other technicians concerned with the selection of tubing for installation in condensers, heat exchangers, evaporators and general piping in power plants, ships, oil refineries and the various process industries.

A special feature is the section devoted to a detailed discussion of the electrochemical theory of corrosion which has been digested from technical reports covering extensive tests conducted by Bridgeport over many years.

The new Bridgeport Condenser Tube Manual has been published in a handy, ready-reference pocket size and you may obtain your copy by addressing a request on your company letterhead.



CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist at the Bridgeport Brass Company

CORROSION FOUND IN STEAM LINES

Natural waters may contain from a trace up to 50 or more parts per million of dissolved carbon dioxide gas. This gas generally comes from (1) the atmosphere, (2) decomposition of vegetable matter, and (3) underground sources. Since ordinary air contains about .04% carbon dioxide by volume, water in contact with air for some time will show approximately 10 parts per million of carbon dioxide. Most waters usually are saturated with oxygen gas derived largely from the atmosphere.

Much of this dissolved carbon dioxide gas is combined in a weak chemical union as the bicarbonate of calcium or magnesium. Some of the carbon dioxide may be combined in a weak union with water to form carbonic acid. The latter combination in chemical analysis is usually referred to as free carbon dioxide.

Effect Carbon Dioxide and Oxygen in Steam

A water containing much bicarbonate will liberate some of this carbon dioxide when it is heated, according to the following reaction:

$$Ca(HCO_3)_2 \overset{heat}{\rightleftarrows} Ca\,CO_3 + H_2O + CO_2$$

This breakdown of bicarbonate may occur in boiler feed water heaters, power and heating plant boilers and so forth.

Since carbon dioxide is appreciably soluble in water, it therefore quite readily dissolves in the condensed steam forming a weak carbonic acid solution, according to the following reaction:

$$CO_2 + H_2O \rightleftarrows H_2\,CO_3 \rightleftarrows H^+ + HCO_3^-$$

While the per cent of carbon dioxide found in such condensates is quite small, it may be enough to cause much damage to steel and iron piping, according to the following reaction:

$$Fe + 2\,H_2\,CO_3 \rightarrow Fe(H\,CO_3)_2 + 2\,H$$

The presence of oxygen in such a steam condensate would be expected to accelerate corrosion by its depolarizing or oxidizing action as follows:

$$2\,H + O \rightarrow H_2O$$

Since both of the gases carbon dioxide and oxygen may be present in closed steam heating and power systems, their combined action may well be the main cause of the serious corrosion which occasionally occurs in such systems. The extent of the corrosive action of this combination varies in degree depending upon the materials used. Copper, red brass, Admiralty metal, aluminum bronze, aluminum brass and certain bronzes withstand this type of attack much better than most ferrous materials which are used in steam lines.

Reducing Extent of Corrosion in Steam Lines

In steam generating plants for heating or power, the corrosion is kept to a minimum by

(1) Generating high purity steam (water treatment, boiler design, and operation);

(2) Preventing contamination of the steam by carbon dioxide and oxygen after it enters the system (air leakage);

(3) Use of the most economical corrosion resistant materials (for pipe, tubes, valves, and so forth).

These remarks also apply to all equipment in which steam is used for heating, such as domestic hot water and steam heating plants, laundries, chemical processing plants (using evaporators, heat exchangers, condensers, and heating coils), food industries, plastic molding equipment and so forth. In such equipment, arsenical copper, phosphorized copper, red brass, Admiralty metal, aluminum brass, Muntz metal, 70-30 cupro nickel and other alloys have been widely used with very satisfactory results.

Effect of Other Impurities

In some instances, waters high in magnesium chloride or organic acid when heated have produced hydrochloric acid or volatile organic acid which have been much more vigorous in their action than carbonic acid. Sometimes these acids are neutralized by the addition of ammonia to the water, or vapors. While such treatment will effectively protect iron or steel, it may accelerate the corrosion of copper base alloys. A steam containing some ammonia may lead to rapid corrosion of non-ferrous metals wherever condensation occurs; for example, condenser tubes. Unfortunately, the reaction proceeds more rapidly when the metal is stressed. Such copper-base tubes are usually covered with a dark blue, black or dark brown colored film, and when flattened or examined microscopically, may reveal trans-crystalline or inter-crystalline cracking. Sometimes the cracking is evident without the aid of the microscopic or flattening test. Failure may occur in a relatively short time. The copper-base alloys vary in their resistance to this type of corrosive attack. Those higher in copper content show greatest resistance to cracking. The 70-30 cupro nickel has the best resistance.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.

A Metal Shear that can be quickly arranged for shearing, squaring, slitting, stripping or notching light and medium weight metals to extremely close tolerances has been made available. The maximum shearing width of the blade is 9 inches. The blade is reversible, offering double service without resharpening. An automatic spring-charged action provides faster operation and greater production output with tolerances to .001 in all duplicated work. **(No. 500)**

A Portable Flaring Tool, recently placed on the market, is designed to produce a double-lap flare on steel and non-ferrous tubing in sizes ⅛ to ⅝ inch outside diameter. The tool consists of a pair of holding jaws and a U-shaped clamp with a built-in vise. The holding jaws are counterbored to provide the exact length of tubing for the correct double flaring of each size. **(No. 501)**

A Gear Tester designed for the inspection of precision gears has been developed recently. An accurate master gear is placed on an arbor while the gear to be tested is placed on an adjacent arbor directly in contact with the master. When these two meshed gears are rotated any divergence or error is shown by the dial on the comparator head, which reads to .001″, .0025″, .0005″ or .0001″ as desired. This device, which is of vertical construction and easily transported, will show gear eccentricity, variation in tooth thickness, errors in spacing, off-center teeth, etc. **(No. 502)**

A Swing Type Grinding Machine suspended by a chain and swivel at its center of gravity has been placed on the market. The grinder wheel operates at motor speed on the end of a shaft extension from the motor. Guide handles lie on either side of the shaft tube. This tube as well as the wheel guard can be rotated to reach large or difficult jobs. **(No. 503)**

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

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SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

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*Trade-name.

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We'd be glad to show this film to key men at *your* organization. There is no obligation whatever for this service. Just drop a line today to the address below and we'll arrange a showing at your convenience.

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Steel Institute have experimented for some years in the hope of finding a low-alloy steel which would have a better corrosion resistance to sea water and at the same time fulfil ship-building requirements and not be too costly.

No steel possessing all the required properties is at present in sight, and the application of paints and compositions seems to be the method most worthy of study. Bottom composition systems generally consist of one or more anti-corrosion coats, followed by one relatively thick anti-fouling coat.

The behavior of the paint system must be considered as a whole. The protective success of a complex paint system depends, in the first place, on the adhesion of the first or priming coat to the ship's plate.

Plates usually undergo one of the three treatments before they are painted in the shipyard, namely acid pickling followed by weathering, weathering only, and weathering followed by a period of immersion in water during fitting-out, the first coat of anti-corrosion composition not being applied until the final docking. All three are followed by scratch-brushing before painting. The first treatment is the general practice in the Royal Navy, and the second is commonly applied in the British Merchant Navy.

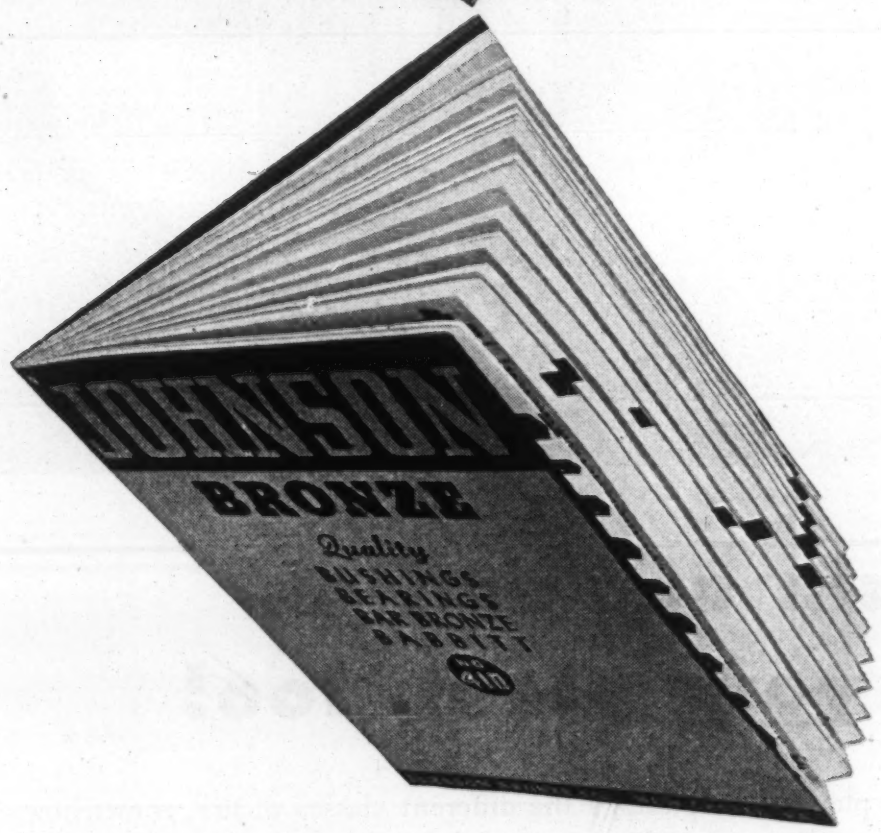
J. C. Hudson has reported that a thinned red-lead paint, which can cover 1500 sq. ft. per gal., has been used as a temporary form of protection on both pickled and unpickled plates (weathered for 21 and 35 days, respectively) and caused a marked improvement in subsequent underwater tests. It is unlikely that temporary protective treatments at the rolling mill, or immediately after pickling, would be satisfactory in the shipbuilding industry.

It is in the early lives of ships that methods of preventing corrosion not based on impermeability are most necessary. Zinc and barium chromates may be better than red lead for continuously submerged areas. To meet the difficulty caused by moisture on the plate at the time of application, J. E. O. Mayne is developing water-emulsion paints, the constituents of which take up moisture into the paint before drying, and thus make for themselves a good seat on the steel plate.

Information is given on the animals and plants that constitute the fouling on ships, their distribution, habits of reproduction and growth and their association into communities large enough to interfere with the progress of the ship; this part of the paper is based on the First Report of the Marine Corrosion Sub-Committee.

—G. D. Bengough & V. G. Shepheard. *Engineering*, Vol. 155, Apr. 30, 1943, pp. 358-360; May 7, pp. 378-380; May 21, pp. 416-417.

IS YOUR COPY DOG-EARED?



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Thermal Expansion of Copper Alloys

Condensed from "J. of Research, National Bur. of Standards"

The linear thermal expansion of some industrial copper - nickel, copper - nickel - aluminum, copper - nickel - tin, copper - tin, copper-lead-antimony, copper-manganese-aluminum, copper-nickel-iron, copper-nickel-zinc, copper-nickel-tin-lead, copper-nickel - zinc - iron, copper - tin - zinc - lead and copper - zinc - aluminum - iron - manganese alloys for various temperature ranges between 20 deg. and 900 deg. C. are summarized in studies extending between the years 1916 and 1943.

The addition of 3 per cent of nickel or the combined addition of 4.5 nickel and 5 per cent aluminum to copper has no effect on the linear thermal expansion. The effects of various heat treatments on copper-nickel and copper-nickel-aluminum alloys is also very small. The coefficients of expansion of two copper-nickel-tin alloys containing 20 and 29 per cent nickel were appreciably less than the coefficients of expansion of copper for the range 20 to 600 deg. C. Three copper alloys containing more than 28 per cent nickel showed the smallest coefficients of expansion of the alloys studied.

The coefficients for all of the alloys tested range between 14.9 x 10^{-6} to 20.4 x 10^{-6} per degree centigrade in the temperature range 20 to 100 deg. C.

—Peter Hidnert & George Dickson, *J. of Res., National Bur. of Standards*, Vol. 31, Aug. 1943, pp. 77-82

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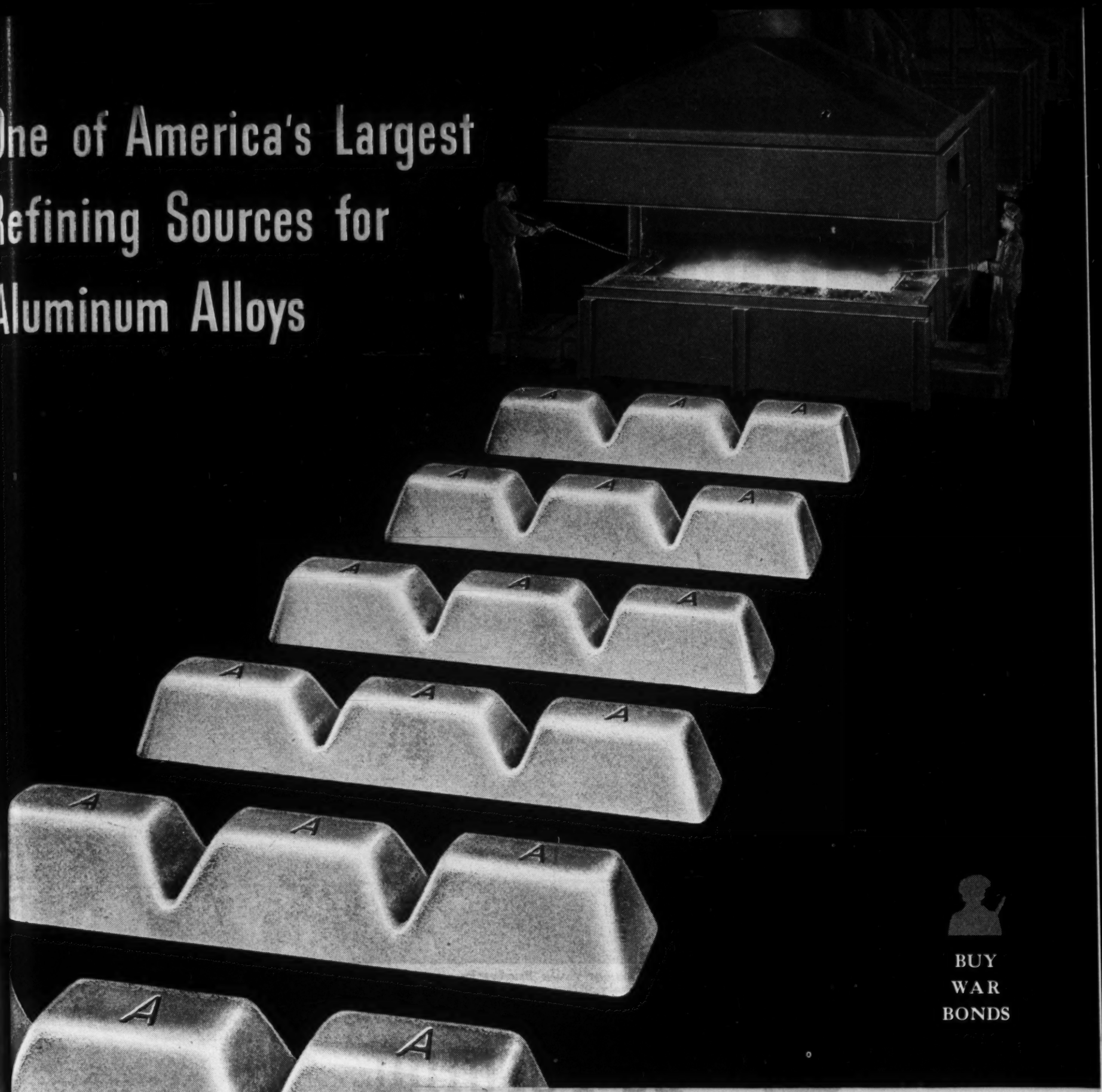

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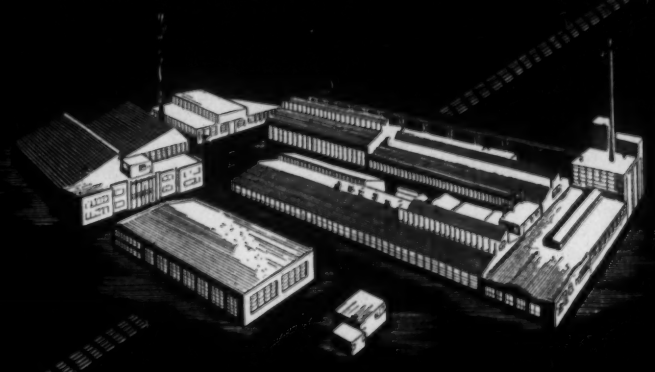

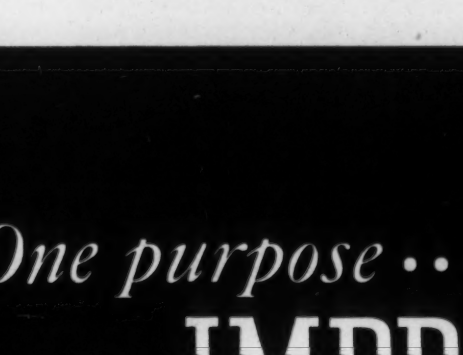

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For example, the process of drop forging provides added strength and stamina through controlled grain flow and metal distribution. Parts can be made with lighter sectional thicknesses without sacrificing heavy duty ruggedness — both size and weight can be reduced. Machining time is likewise reduced to a minimum.

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CONTENTS

Inspection of Welded Pressure Vessels and Piping ——— 1180

Double-Exposure Radiography ——— 1184

Extension Speed in Creep Testing ——— 1187

Inspection of Welded Pressure Vessels and Piping

Condensed from an
American Welding Society Paper

The available methods of inspection of welding, namely, visual, radiographic, sampling and magnetic powder are all applicable, in at least some degree, to pressure vessels and piping. In fact, some of these methods are mandatory in the widely recognized construction codes such as the ASME and the API-ASME Pressure Vessel Codes. Except for the specific requirements of such Codes, any decision as to what method of inspection should be followed must be based on the nature of the information desired.

It may be presumed that the principal objective in the inspection of welding is to determine that the weld is sound, and by that it is meant that the welded joint has satisfactory penetration, is well fused, and is free from objectionable or harmful slag inclusions, cracks or porosity. It is, of course, necessary that in some way it be determined that the weld metal is of satisfactory tensile strength and ductility, and that the base material has not been injured by the process of welding. Information of this nature can best be determined by the adoption of proper welding practices that have been developed by proper research or by long usage so that experience has shown them to be satisfactory.

The weldability of the base material should be known, and the suitability of the electrode to be used must be well established. In many instances, such as in the case of the construction codes previously referred to, it is necessary that the fabricator establish his method of welding, giving consideration to all essential variables, and that a test then be made to determine that such method may be expected to give welded joints of acceptable tensile strength and ductility. In some cases, for instance in the ASME Boiler Code and for certain types of vessels in the Unfired Pressure Vessel Codes, specimen welds must be made and tested for each vessel.

The developments in metal arc welding that have taken place in the last decade are such that there now exists a rather extensive knowledge of what constitutes good welding practice to obtain weld metal of satisfactory tensile strength and ductility and to avoid injury to the base material, so that inspection of welding today is focused not so much upon the question of tensile strength and ductility as it is upon the soundness of the weld.

The visual method of inspection for soundness of welds is applicable primarily only while the weld is being made. While the contour of a finished weld may furnish some information regarding its probable soundness provided, of course, that there is definite knowledge of the manner in which the parts were prepared for welding, such surface inspection cannot be expected to give any positive knowledge of the soundness of a weld. Unfortunately a weld that "looks all right" on the surface may be a very unsound one.

Visual examination of a weld as it is made affords an opportunity to determine that the parts have been properly prepared for welding, that acceptable materials are being used, that the welding operator is keeping the weld free from serious slag inclusions, and that the weld is being fused to the base material. It has been shown that the visual method of inspection is productive of very reliable results provided competent welding operators are used, the inspector is capable, and the inspection is extensive enough to watch every inch of the welding. Such inspections, sometimes referred to as "man to man inspections," require an inspector for every welding operator and is thus expensive.

On the other hand, a somewhat less exacting program of inspection, but based upon the use of competent welding operators as determined by test, supervision by competent foremen, and check inspections from time to time to see that proper practices are being followed, has been productive of a grade of welding that has proven itself reliable for a great many classes of service.

Radiographic Methods

The radiographic inspection of welding may be carried out by the use of X-ray or by gamma-ray. The former is accomplished by the use of an X-ray tube and the latter by the use of a capsule of radium or of radium emanation.

The X-ray method is most generally applicable in the shops of manufacturers of pressure vessels, although some X-ray examinations have been made in the field.

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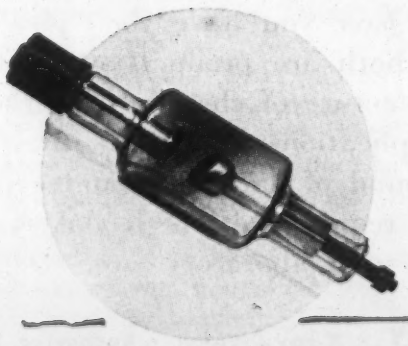

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However, such applications of the X-ray method in the field is limited because of the bulk of the equipment involved. On the other hand, the gamma-ray method involves equipment of relatively small bulk.

The radiographic method of inspection is most suitable on butt welds where both sides of the weld are readily accessible. The method is less applicable to welds attaching nozzles to shells.

Either method of radiographic examination as commonly used furnishes a record on a photographic film, and the principle of either one is that any defect such as a slag inclusion, porosity, certain types of cracks and serious lack of fusion do not absorb the penetrating ray to the same degree as solid weld metal or the base material, and thus these defects are shown on the film as dark areas. The interpretation of such evidence on the radiographic film are not too difficult to make but do require some degree of experience.

It appears that there has been some tendency to view radiographic methods of inspection as being quite complete. On the other hand, it is believed that all those who have had experience with this method of examination will agree that there are certain types of cracks or lack of fusion that are not detected by X-ray examination as ordinarily applied.

With particular reference to cracks it should be understood that the plane of the crack must be parallel to the penetrating ray or, at least, nearly so. Fortunately, a crack that is of any depth in a butt weld will usually be in that plane and can, therefore, be detected by radiographic examination, although careful radiography is necessary as is also close examination of the radiographic film.

Sampling of Welds

The sampling method of inspection of welding may be carried out either by the trepanning of plugs or by the removal of a boat-shaped specimen as is accomplished by the use of equipment known as a "weld prober." Either of these methods remove samples from the welded seams at selected points. These may be locations that are definitely under suspicion or they may be selected at random to get an idea of the average quality of the weld or to exert a psychological pressure upon the welding operator that any part of the weld that he makes may be so examined. Of course, when used in this manner, the welding operator should know in advance that such an examination will be made of his welds.

When plugs are removed by trepanning, the hole so made is sometimes closed by a threaded plug, which may be seal welded for tightness if so desired or a plug may be welded into the hole. There has been some objection to this method of examination when the hole is closed by welding, as some have felt that severe stresses are set up by welding in a constricted place.

The boat-shaped specimens removed by the weld prober provides material that can be tested in several ways such as for soundness, for tensile strength, and for ductility. The opening left in the weld is similar in many respects to a welding groove and thus lends itself readily to rewelding without great difficulty.

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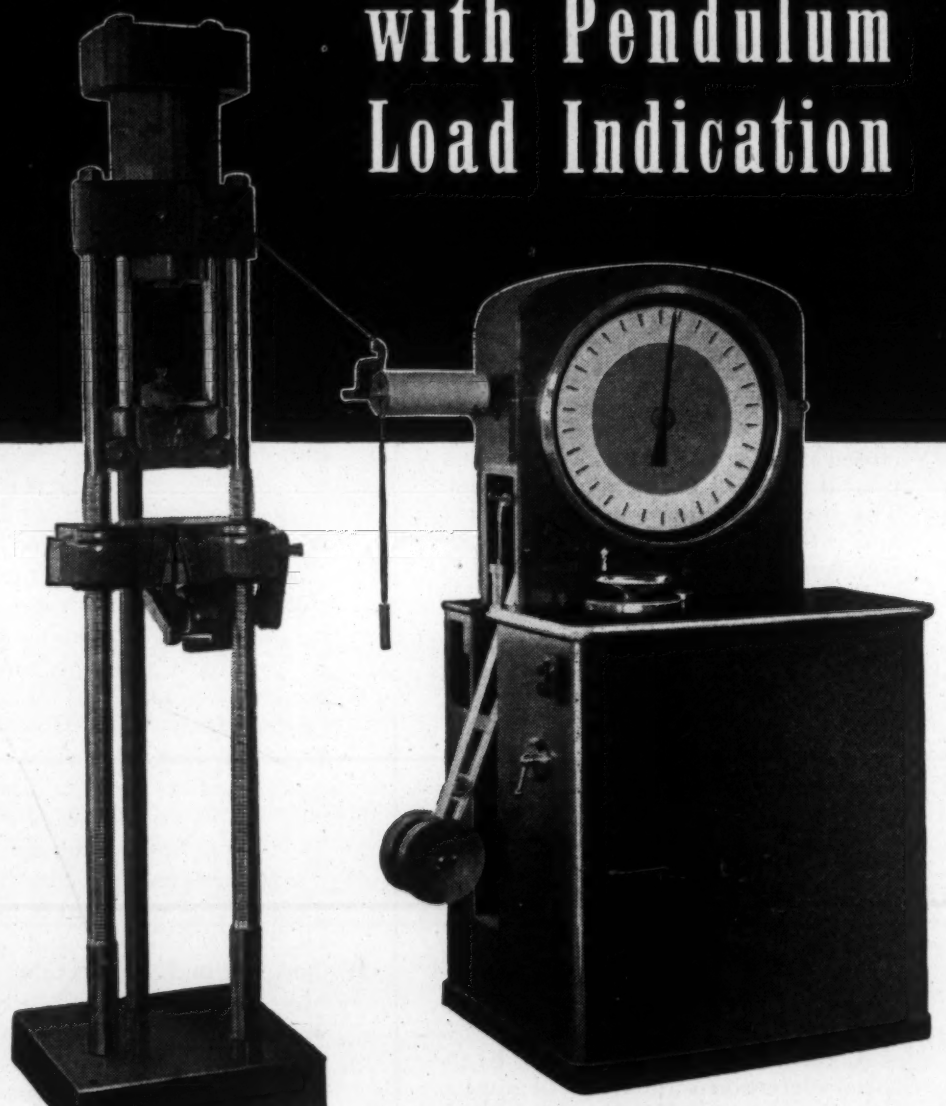

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The magnetic powder method of inspection involves the magnetizing of the portion of the weld to be examined and then applying a suitable para-magnetic powder, such as iron filings, to the surface. When properly magnetized, the powder will gather at any crack that extends to the surface and may also, by a similar indication, reveal sub-surface defects, provided they are not too far below the surface and provided they are of sufficient magnitude to provide the magnetic field at the surface, which will hold the powder in contact with that surface.

Inasmuch as cracks that develop in welds as they are being made are one of the most serious types of defect that may be encountered, and are frequently difficult to detect except upon a most minute examination, the magnetic powder method of inspection is valuable for use as a weld is being made to insure that no cracks exist in a given layer of welding before the subsequent layer is deposited. In many instances this method of inspection has been used for each layer of welding as applied, and where radiographic methods were not available, and in many instances cracks have been found which were repaired before further welding was done.

As our experience with welding and its application to more extensive fields increases, the probability of defective work decreases provided, of course, that those who use welding understand its fundamental principles and what must be done to insure good work. This means further that intelligent foremen and supervisors are necessary, and that honest and competent workmen are employed to do the work. Where such intelligence and honesty are applied, inspection becomes less necessary than in the case where slipshod methods and short-change practices are the vogue.

—W. D. Halsey. Paper, Am. Welding Soc., October 1943 meeting.

Double-Exposure Radiography

Condensed from "Transactions," American Society for Metals

To detect the vertical position of flaws in metal parts, it is possible to make two stereoscopic exposures on the same film. The vertical height above the film of the flaw producing the image may be found by the following formula (No. 1): No (flaw-film-distance) $= \frac{\text{focal dist. x image shift}}{\text{tube shift} + \text{image shift}}$

By placing a lead marker on the specimen being radiographed and noting the shift of its image on the film, either the flaw-film distance or the focal distance may be eliminated. By assuming the X-rays to be parallel a simplified and sufficiently accurate formula, (No. 2), utilizing the lead marker, is derived as follows:

Flaw-film dist.$=$ $\frac{\text{marker-film dist. x flaw image shift}}{\text{marker image shift}}$

Experiments were conducted to determine the accuracy with which holes could be located in aluminum and steel castings by these methods. The tube used was a Phillips Metalix Macro 200 p.k.v. type with water-cooled stationary anode. All exposures were made at 5 ma. The time was measured from an arbitrary position of a protective rheostat because the voltage had to be brought up slowly by means of the rheostat. The perpendicular focal distance (target to film) was taken as 91.8 cm.

Test parts for aluminum were unmachined cast aluminum bars, 48 x 7.5 cm., of different thicknesses. Each casting had twelve holes, 6.4 mm. in diam. of varying depths. The maximum possible error in recording these depths and the thickness of the casting is about ± 0.3 mm. Test castings 1 and 2 in. thick were radiographed with the holes on top and also next to the film. Those 1¼ and ¾ in. thick were superimposed and radiographed together with the holes at the inner faces. Non-Screen film with 0.2 mm. lead filters was used.

Steel Tests

For steel, test specimens consisted of cast steel blocks 11 by 3.8 by 1.3 cm. and 11 by 318 by 215 cm., with grooves 1.3 cm. wide in which were fitted slotted bars of two kinds. The first contained slots 0.3 cen. wide and varied in depth from 0.25 to 2.0 mm.; possible error ± 0.04 mm. The other had slots 0.32 cm. wide, varying in depth from 0.5 to 3.0 mm.; possible error, ± 0.1 mm. Two of each size were radio-

(Continued on page 1187)

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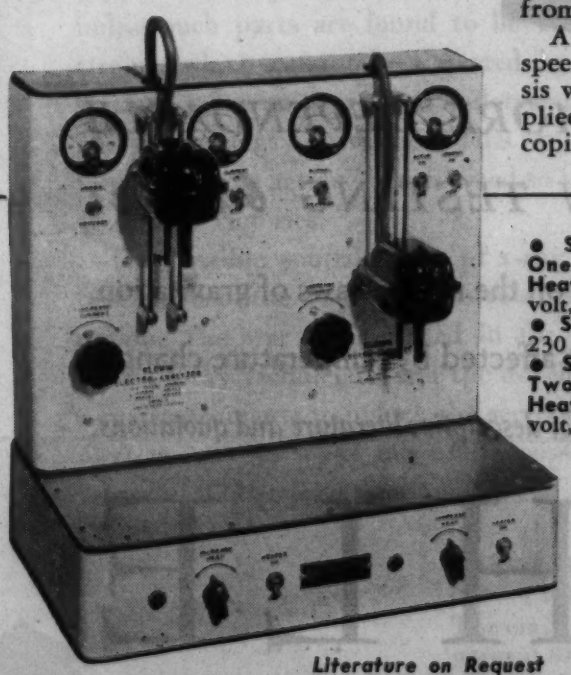

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graphed together, one slotted bar on top and one between, making the total thicknesses 2.5 and 5.1 cm. High-speed film with two intensifying screens was used as Non-Screen film was unsatisfactory.

In working with aluminum it was found that drilled holes greater than 10 per cent of the casting thickness produced images of such clarity that their tops and bottoms could be located and the depths of the holes estimated. The errors in the calculations of depth were usually of the order of —50 per cent. The location of the holes themselves was found to be possible with errors usually much less than ± 10 per cent of the casting thickness and often under ± 3 per cent when sensitivity was under 4 per cent. As the experimental holes were of uniform shape, these errors correspond to optimum conditions. A tube shift of 1 ft. was found adequate except when the holes were near the bottom of the casting when a larger shift gave better results.

In working with steel, it was not found possible to distinguish between images of the tops and bottoms of the slots so each measurement was made from the edge of the image and recorded as the middle of the slot. Results of the experiments compared favorably with those on aluminum. The desirability of good technique, giving greater sensitivity was clearly shown. With both metals it was noted that the errors in using the second equation were more negative than those made with the first.

—James Rigby, *Trans. Am. Soc. for Metals*, Vol. 31, Sept. 1943, pp. 599-608.

Extension Speed in Creep Testing

Condensed from "Archiv Eisenhüttenwesen"

In investigating creep processes it had been observed that the elongation velocity as a function of the tension does not increase uniformly but slowly at first and, beginning at a fairly narrow load range, fairly quickly. This discontinuity point becomes especially distinct by plotting the curve logarithmically. Practically all technically important mettals (steel, lead, aluminum, magnesium, copper and tin) show this bend very distinctly, and its location is a measure for the creep strength.

The branch of the curve with the greater elongation velocity is more strongly dependent on temperature and steel composition. The occurrence of the bend is due in particular to the condition that for small loads a general flowing of the material is prevented by reason of the polycrystalline structure and the increase of strength with tension.

The high flow velocities at high loads are caused especially by strong formation of gliding planes. The distinct discontinuity point must, therefore, be considered as an indication of a material easily characterized as creep-resistant.

An exception can occur if in spite of a distinct bend the material yet is not creep resistant; in this case other processes are at work that cause a softening of the material, *e.g.* precipitations. This phenomenon must still be further investigated in materials *after* the creep test.

—F. Sauerwald, *Arch. Eisenhüttenw.*, Vol. 16, Jan. 1943, pp. 269-272.

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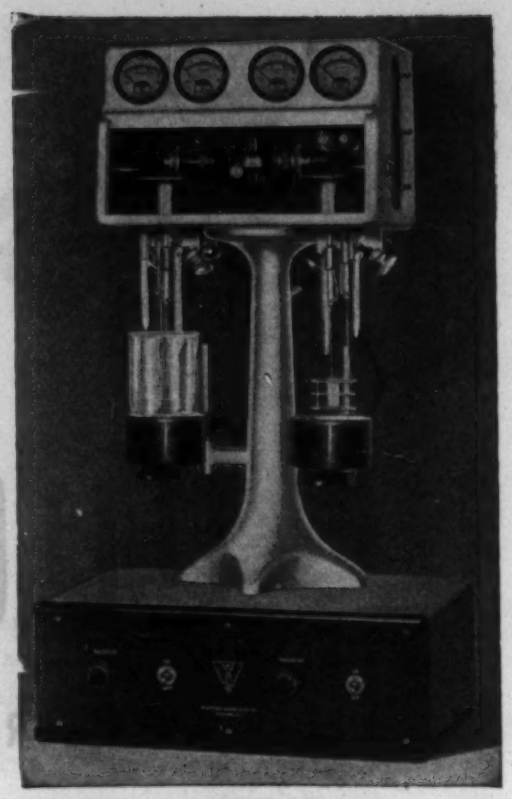

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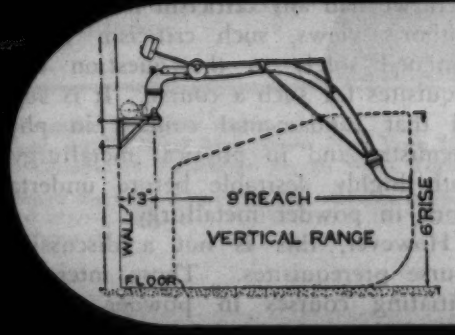

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METALS AND ALLOYS DATA BOOK. *By S. L. Hoyt. Published by Reinhold Publishing Corp., New York, 1943. Cloth, 7 x 10¼ in., 334 pages. Price $4.75.*

Engineers, metallurgists, and others applying materials for design or construction, are often confronted with new problems which require referring to data on properties of materials. These data have been collected from isolated sheets and publications which, once filed, are difficult to locate. Dr. S. L. Hoyt has rendered a real service in compiling a large amount of miscellaneous data covering the properties of metals in a compact volume which will permit many such files to be brought up-to-date by transferring the obsolete information to the waste basket.

The book is conveniently divided into chapters on Wrought Steels, Cast Steels, Stainless Steels, Cast Iron, and Non-Ferrous Metals. The data on the new National Emergency Steels are quite complete. Hardenability and "S" Curves are presented in such a way that they can be readily used by anyone who may not have a comprehensive knowledge of the subject. The chapters on Cast Steels and Stainless Steels are very complete, including such widely separated properties as corrosion resistance, thermal expansion, creep and allowable design stresses.

Each chapter contains a reference to government, industrial, and appropriate specifications issued by engineering societies. The chapters on Non-Ferrous Alloys incorporate available data on aluminum, magnesium, copper, nickel, tin, lead, and zinc base alloys, with additional paragraphs giving information on useful industrial properties of all the metals in the periodic system.

It is hoped that this first edition will be revised periodically so that it will continue to present the latest and best information on new and old alloys. A book of this type is of the most use when a reader becomes thoroughly familiar with it so that he knows just where to turn to find the desired information. Before using the book, it is desirable to read the Preface as this represents an exceptionally condensed and clear exposition of the use of data on properties of materials.

—J. B. JOHNSON

Powder Metallurgy

A COURSE IN POWDER METALLURGY. *By Walter J. Baëza. Published by Reinhold Publishing Corp., New York, 1943. Cloth, 6¼ x 9¼ in., 212 pages. Price $3.50.*

An introductory course in Powder Metallurgy, covering in general the basic principles and modern practice of this newest of metallurgical processes.

No book, no matter how written, can hope to cover every phase of the subject matter fully. The author has succeeded very admirably in presenting essential data and information with which an introductory course in powder metallurgy can be made both interesting and instructive.

If we had any criticism to make of the author's views, such criticism would be confined solely to the question of prerequisites for such a course. It is suggested that fundamental courses in physical chemistry and in physical metallurgy are both highly desirable before undertaking work in powder metallurgy.

However, this is not a discussion of course prerequisites. Those interested in initiating courses in powder metallurgy will find ample material for introductory work in lectures and in laboratory in this book.

—CLARK B. CARPENTER

Plastics Handbook

HANDBOOK OF PLASTICS. *By Herbert R. Simonds, Carleton Ellis and M. H. Bigelow. Published by D. Van Nostrand Co., Inc., New York, 1943. Cloth, 7 x 9½ in., 1082 pages. Price $10.00.*

One might have doubted, five years ago, the existence of enough basic technical data on plastics to fill a 1,000-page handbook. Today one is astonished that so much useful material was successfully packed into no more than 1,000 pages. All of which epitomizes the fabulous growth of the plastics field; including (as does this book) natural resins, synthetic rubbers and synthetic coatings.

The book is divided into 9 sections including an introduction outlining broadly the nature of the "plastics industry" and giving many data on individual companies, and an appendix whose glossary of terms, identification of trade names and bibliography alone are of unusual value. There are sections on properties, raw materials, plastics production, fabrication methods and equipment, chemistry of plastics, applications and part design, and commercial considerations.

There has been no skimping. Each topic is covered intensively and exhaustively and none seems to have been omitted. Metal industries engineers will welcome this volume as their "bible" on these new industrial materials.

—FRED P. PETERS

World Minerals

MINERALS IN WORLD AFFAIRS. *By T. S. Lovering. Published by Prentice-Hall, Inc., New York, 1943. Cloth, 6¼ x 9¼ in., 394 pages. Price $5.35.*

Written by the professor of economic geology at the University of Michigan, this is not a geology textbook. Indeed, what geology is included is not very essential to the main theme. The high spot of the book is a survey of world history, starting around 3000 B.C., as related to raw materials, transportation routes, facilities, and the impact of improving and changing technology. From this background, military war and trade or economic wars for possession of or access to, supplies of mineral raw materials are traced through the industrial era, World War I, and the present conflict.

Then the location, amount, and political and financial control of important deposits, all over the globe, are recorded for coal, oil, iron and steel, manganese, chromium, nickel, tungsten, molybdenum, vanadium, copper, aluminum, lead, zinc, tin, mercury, and antimony. The metallurgy and technology of each are discussed in very sketchy fashion, for the enlightment of the general reader.

A few minor slips are made in the metallurgical discussions; for example, lead foil and aluminum foil are classed as equally toxic as food wrappings to substitute for tin foil; molybdenum steel is said to be a substitute for manganese steel; soon after the discussion of austenitic manganese steel, the impression is given

(Continued on page 1190)

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Noted Contributors

These men realize the desperate need for such training in the production world of today, and for that reason contribute their help. Among the noted contributors are: Frederick W. Pickard, Vice President and Director, E. I. du Pont de Nemours & Co.; Alfred P. Sloan, Chairman of the Board, General Motors Corp.; Clifton Slusser, Vice President, Goodyear Tire & Rubber Co. and Thomas J. Watson, President, International Business Machines Corp.

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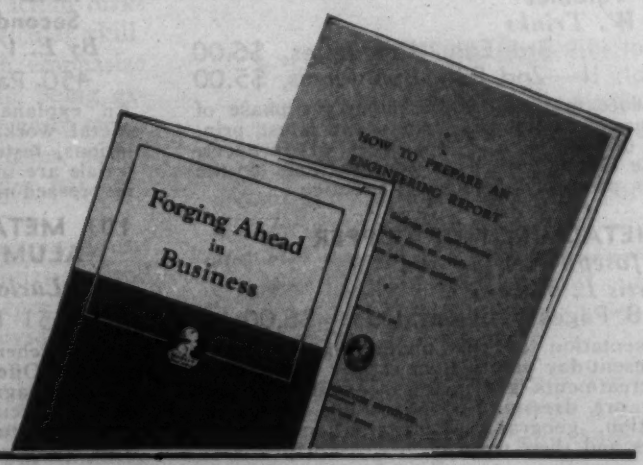

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This book is concerned with the production of iron and steel. Contains condensed descriptions of equipment accompanied by simple line drawings. Statistical material has been kept to a minimum. A valuable book for metallurgists.

2) NON-FERROUS PRODUCTION METALLURGY
By John L. Bray
430 Pages Illustrated $4.00
For the metallurgist who wishes to brush up on his knowledge or to become acquainted with recent phases of metallurgy. Material is presented in a simple, concise manner. Includes such notable features as full economic and tariff discussion, thermal data for reactions, simplified flow sheets with line drawings, statistical tables confined to production and prices in important countries in significant years.

3) THE METALLURGY OF DEEP DRAWING AND PRESSING
By J. Dudley Jevons
699 Pages Illustrated $10.00
This book represents a great saving in time and effort for the engineer. In one volume is a collection and critical examination of recent developments in metallurgy as applied to deep drawing and pressing. Emphasis is on the everyday practical problems of industry.

4) INDUSTRIAL FURNACES, 2 Volumes
By W. Trinks
a) Vol. I—3rd Edn. 456 Pages, $6.00
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Up-to-date material on an important phase of metallurgy. Volume I covers the latest principles of design and operation of furnaces. Volume II, although a continuation of the first, is primarily devoted to practice.

5) METALLURGY OF COPPER
By Joseph Newton and Curtis L. Wilson
518 Pages Illustrated $6.00
A presentation of the underlying principles and present-day practices in copper metallurgy. Brief treatments are included on the uses of copper, ore dressing, copper alloys and their fabrication, geographical distribution of copper ores and their nature.

6) STEEL AND ITS HEAT TREATMENT, Fourth Edition
By D. K. Bullens and the Metallurgical Staff of Battelle Memorial Institute
a) Vol. I 445 Pages, $4.50
b) Vol. II 491 Pages, $5.00
Modern practice in the heat treatment of steels and the underlying principles involved are presented in this treatise. Volume I includes sections on metallurgical principles, surface-reaction processes and control of heat-treating operations. Volume II covers simple and complex engineering steels and special-purpose steels.

7) AN INTRODUCTION TO METALLURGY
By Joseph Newton
537 Pages $4.00
Answers in a clear concise manner the three fundamental questions of metallurgy: What are metals and alloys? Where are the sources of these metals? How are these metals extracted?

8) GENERAL METALLOGRAPHY
By R. L. Dowdell, H. S. Jerabek, A. C. Forsyth and C. H. Green
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Written from an engineering viewpoint, this book covers the fundamental principles of both ferrous and nonferrous metallography. Serves as an excellent introduction to the many specialized treatises and technical literature now available.

9) PLASTIC WORKING OF METALS AND POWER PRESS OPERATIONS, Second Edition
By E. V. Crane
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10) METALLOGRAPHY OF ALUMINUM ALLOYS
By Lucio F. Mondolfo
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A comprehensive, practical study of aluminum alloys. Offers a complete collection of equilibrium diagrams, describes the microstructure of commercial aluminum alloys and illustrates the constituents commonly present. Illustrated with original photomicrographs.

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(Book Reviews *Cont. from page 1188)*

that straight chromium steels have remarkable high temperature strength in contrast to molybdenum steels; and phosphorus is said to be removed in iron smelting by mere contact with magnesium oxide. There are various other slips of like nature, none of which affect the soundness of the main argument.

Lovering believes that Japan built up quite ample stock piles of all important raw materials. Without arguing the point directly, it is indirectly made abundantly clear that the United States ought to acquire ample stock piles against future emergencies.

The book is well written. The reviewer spent, pleasurably, nearly as many hours on it as he had expected to spend minutes in going over it for review.

—H. W. GILLETT

Handbook of Chemistry, Physics

HANDBOOK OF CHEMISTRY AND PHYSICS. *By Charles D. Hodgman and Staff. Published by Chemical Rubber Publishing Co., Cleveland, 1943. Fabrikoid, 5 x 7½ in., 2553 pages. Price $4.00.*

The 27th edition of the Handbook of Chemistry and Physics, published by the Chemical Rubber Publishing Company, Cleveland, has just come off the press. The latest edition of this standard reference work contains about thirty pages more than its immediate predecessor. A supplementary table on alloys includes many of the more common non-ferrous compositions which have assumed wartime importance, and some of the NE steels. The list needs a little pruning or revising as to some of its older members, however. Some of the names and compositions have apparently been carried along even though the composition of the metal has been changed, or the original name is no longer in general usage.

Specific gravity, coefficient of expansion, and melting point are listed, but all these values are given for less than half of the alloys mentioned. The sections dealing with X-ray and crystallographic data have been supplemented pending a complete revision of text pertaining to this rapidly developing subject. Data upon emission spectra should prove of interest.

—KENNETH ROSE

Other New Books

FUEL OIL AND ITS COMBUSTION. *Published by The North American Mfg. Co., Cleveland, 1943. Fabrikoid, 5 x 7½ in., 37 pages. Price $1.50.* This booklet has been prepared by the research department of the North American Mfg. Co., for the users of fuel oil. It contains considerable original material and a synopsis of data pertaining to fuel oil. The four leading topics discussed are "Crude Oil Constituents and Classifications," "Crude Oil Processing," "Properties of Fuel Oils" and "Fuel oil Combustion."

THE INGOT PHASE OF STEEL PRODUCTION—2D EDITION *By Emil Gathmann. Published by The Gathmann Engineering Co., Baltimore, Maryland, 1942. Cardboard, 7 x 10¼ in., 141 pages.* This second edition gives details of the basic information contained in the first. There has been included a review of cross sectional contours of various types and a chapter has been added on the economic value of big-end-up production. The highlights of a test conducted by the Bureau of Standards on rail steels make up another section.

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

An Electronic Testing Apparatus

A testing device with a wide range of possibilities, the Cyclograph, has been produced by the *Allen B. Du Mont Laboratories, Inc.*, Passaic, N. J. At a demonstration at their plant October 8, the instrument detected variations in hardness of steel parts, eccentricity of case in case-hardened pieces,

picked out bundles of welding rod containing one or more defective pieces, and operated an automatic sorting device that separated copper-clad steel cups showing variations in the cladding metal.

The Cyclograph is an electronic apparatus for testing metals, both magnetic and nonmagnetic, for correspondence with a given standard. A cathode-ray tube provides the indicator. Properties of the metal that may be studied are: case depth, carbon content, brittleness, variations in heat treatment, chemical composition, or plating thickness. In order that the variation of the property in question be measurable, it is necessary that other properties remain reasonably constant.

Comparison is made upon the basis of core losses in a coil at different frequencies. Three frequencies are usually used, currents being applied simultaneously. The selection of the proper frequencies is a matter for an electronics engineer, and for this reason the instrument is offered upon a rental basis only. Settings are predetermined at the plant for given applications, and the actual making of the test requires no particular skill.

Frequencies are chosen which emphasize the particular metal characteristic being examined. If chemical analysis or grain structure is in question, low frequencies, sometimes of the order of 500 cycles per sec., will give widest variation.

With magnetic metals, the hysteresis losses form a basis for differentiation, and currents of much higher frequency may be used. Eddy current losses provide an additional characteristic.

If surface structure is to be studied, the higher frequencies, which have a pronounced "skin effect," will be used. For nonmagnetic metals, eddy current losses and the condition sometimes called mechanical hysteresis, or molecular vibration, provide differential characteristics. These are best studied at ultra-high frequencies.

By combining the effects of several frequency readings, each giving its maximum response for a given set of conditions, a more reliable determination can be made than would be possible considering one property only.

The tests are non-destructive, and so can be used on finished parts. They can be planned to be used for every piece, even with small parts, and so improve quality control. A test requires only a few seconds to make, and can be performed even on articles already packaged, under proper conditions.

The apparatus will not make chemical analyses, nor indicate variation from a standard in one property if several other properties vary simultaneously. It is offered as a valuable supplemental test.

Gas Pressure Regulator

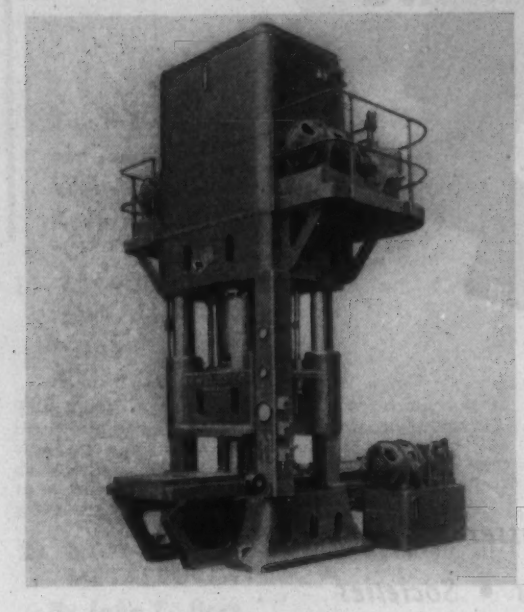
A new gas pressure reducing regulator is available for inlet pressures up to and exceeding 4,000 per sq. in. and for delivery pressures up to and over 1,000 per sq. in. It is designed particularly for refilling to 400 and 800 per sq. in. smaller cylinders from cylinder manifold systems, and is made by the *Victor Equipment Co.*, 844 Folsom St., San Francisco.

Greater pressure accuracy is due to a specially-designed diaphragm that is gas-loaded instead of spring-loaded, with damage to the diaphragm virtually impossible. Loading pressure of the main regulator is controlled by a built-in pilot regulator, the tension screw of which is so arranged that it will not permit a diaphragm loading pressure beyond a predetermined maximum.

If the operator wishes to diminish a previously set operating pressure, he merely releases the tension screw of the pilot regulator and exhausts the dome pressure by a non-leak release valve.

1,100-Ton Hydraulic Forging Press

A 1,100-ton, self-contained hydraulic forging press, equipped with 35-ton ejector and a sliding die table is announced by *E. W. Bliss Co.*, 53rd St. and Second Ave., Brooklyn 32, N. Y. It is electrically controlled and properly interlocked so that the press, die slide and ejector operations can only occur when the different actions are in their proper positions.



The 150 h.p. pumping unit permits speeds of: quick advance, 750 in. per min.; pressing, 37 in. per min.; return, 725 in. per min.

Four methods of operation are provided for the main slide: (1) Semi-automatic cyclic operation—press completing one press cycle and then stopping; (2) full automatic operation—press slide operating continuously until a stop button is depressed; (3) joggling control by means of a drum type switch permitting small reciprocations of the press in answer to the positions of the drum type switch and also retaining the quick advance and quick return features; (4) inching control, permitting small increments of approach of the press by push button, the press descending only as long as the down button is held depressed and only at pressing speed and opening only as long as the up button is held depressed.

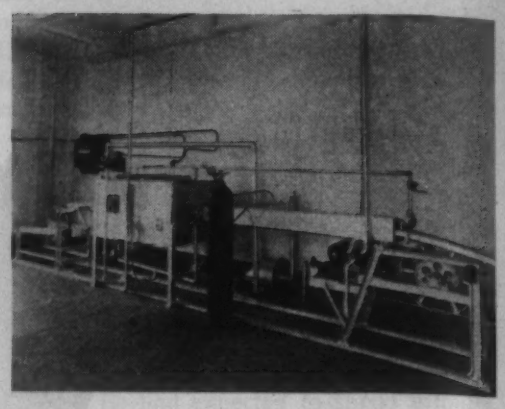
This inching control retains the same safeguards against over-pressure and over-travel as the production control.

Furnace for Brazing, Soldering, Sintering, Etc.

A small furnace for continuous automatic brazing of copper pieces, silver soldering, sintering or bright annealing of metal strips, bands, etc. that requires a uniformly bright high surface finish is announced by *W. S. Rockwell Co.*, 50 Church St., New York 7.

Pickling, cleaning and drying are unnecessary. Design permits the utilization of gas, with a burner firing from each furnace end, though electric heating can also be arranged Automatic temperature control is provided.

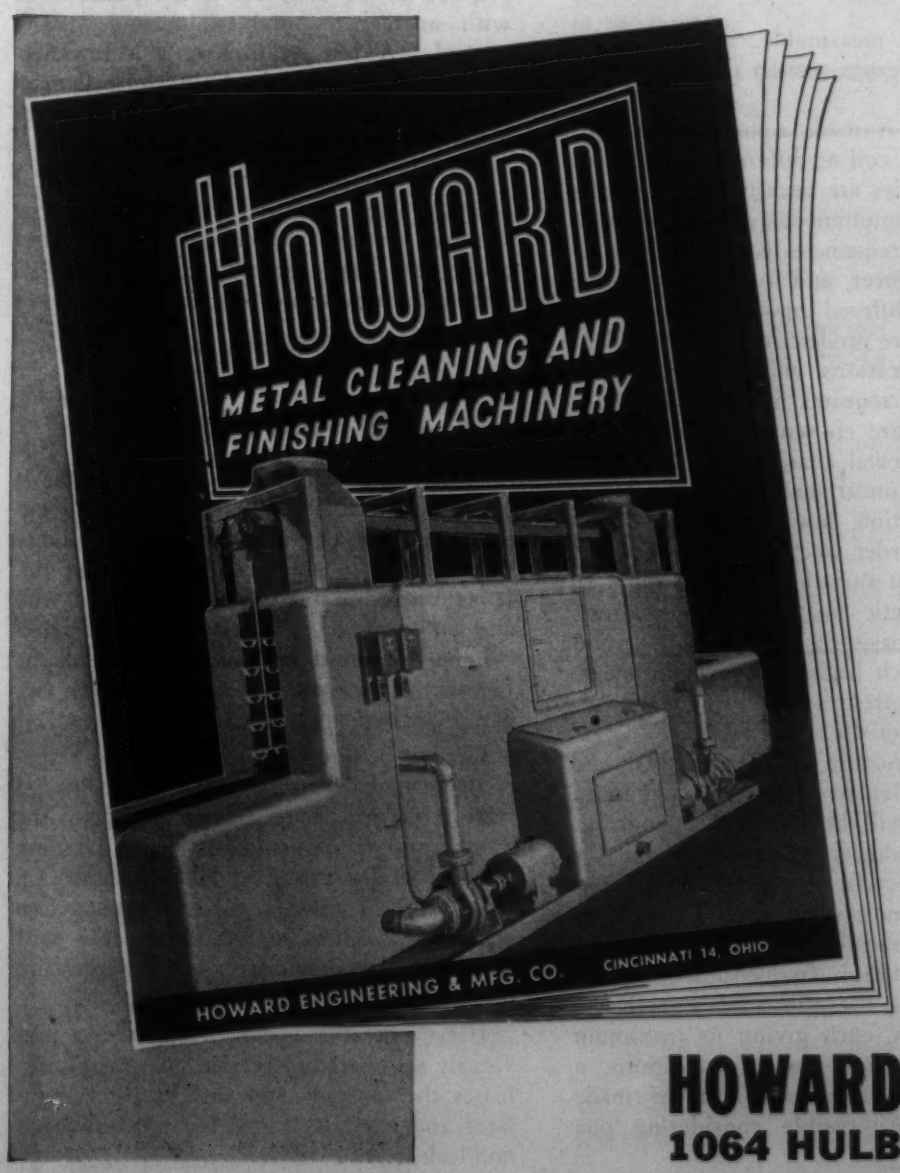
The work moves on a continuous mesh



belt conveyor into a small enclosed charging neck and then into a square muffle, emerging into an enclosed water-cooling zone. Dimensions of the above components depend on size, quantity of pieces to be treated and speed of travel. The muffle is of Nichrome.

A controlled reducing atmosphere is maintained in the muffle and cooling chamber by introducing hydrogen drawn from a cylinder.

● Poroseal is a new non-organic coating for metals, available in a wide range of colors, has a very high resistance to heat and resists corrosion, acids, solvent and abrasion. It is made by *Pemco Corp.*, Baltimore.



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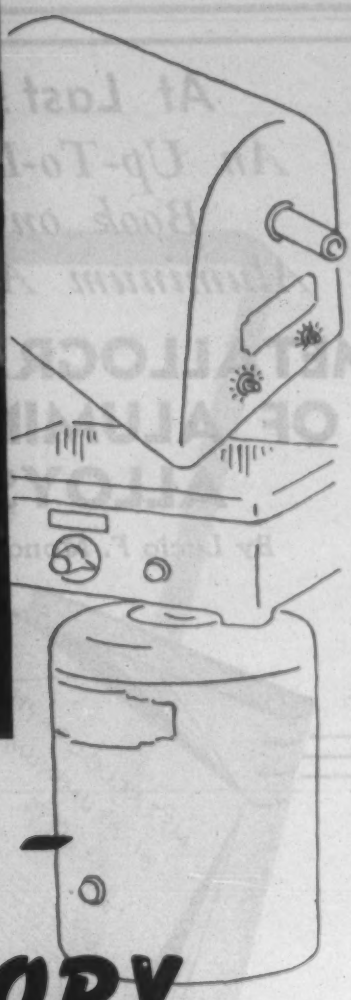

Performance plus--
FOR YOUR LABORATORY

WHEN it's a question of performance, discriminating laboratory technicians will want to benefit by the results obtainable with the new Lindberg Box Type Laboratory Furnace. Ash determinations, fusions, ignitions, drying precipitates, heat treating small parts and many other operations, are efficiently and accurately handled by this single unit.

Careful design and durable construction, as well as appearance, add that certain "plus" for which all Lindberg equipment is widely known. Let's look over these important features.

Appearance

- Streamlined and clean. Adds to modern laboratory standards.

Construction

- Rugged. Heavy sheet metal housing encloses courses of selected high temperature insulating slabs and refractory brick.
- Vertical lift mechanism raises door so that hot side is always facing away from operator.
- A convenient ledge is revealed when door is open.
- Heavy rod type low voltage nickel chromium elements. Excellent for temperatures up to 2000°F. Long life, few replacements.
- Built-in transformer provides reduced voltage.

Operation

- Lindberg Input Control accurately provides "stepless" apportioning of heat.
- Indicating pyrometer registers the temperature throughout the range of furnace applications.
- Index pointer on pyrometer gives visual check on furnace control.
- Signal light shows when furnace is in operation.

Two Sizes

- Temperature range up to 2000°F maximum.

CHAMBER SIZES

B-2 4½" wide x 10" deep x 4" high
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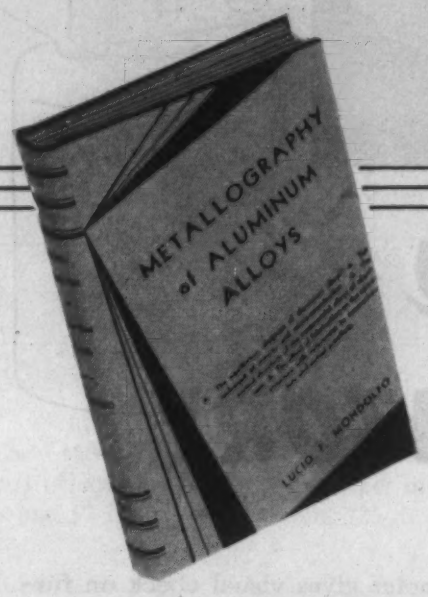
An Up-To-Date Book on Aluminum Alloys

METALLOGRAPHY OF ALUMINUM ALLOYS

By Lucio F. Mondolfo



A comprehensive, practical study of aluminum alloys. The growing interest and continuous development in the use of aluminum alloys, and the fact that present works on the subject are out-dated made the publication of this volume imperative.

It deals with equilibrium diagrams of aluminum alloys; the technique of macro and micro examination; the normal structure of commercial alloys; the effect of fabricating on micro and macro structures and many other related topics. Illustrated with original photomicrographs. Will be invaluable to men in the aluminum industries or aircraft factories and to engineers concerned with the use of aluminum.

351 Pages **$4.50**

Contents

Equilibrium Diagrams
Polishing and Etching
Commercial Alloys
Effect of Fabricating on the Microstructure

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Please send me a copy of Mondolfo's METALLOGRAPHY OF ALUMINUM ALLOYS on ten days' trial. At the end of that time, if I decide to keep the book, I will remit $4.50 plus postage; otherwise I will return the book postpaid.

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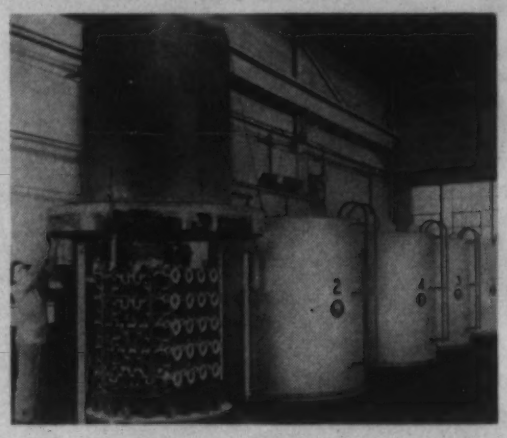
Furnaces for Nitriding Crankshafts

For nitriding Rolls Royce aircraft engine crankshafts at the *Packard Motor Car Co.'s* plant at Detroit, a battery of Westinghouse bell-type furnaces is used.



In addition to close nitriding case depth and hardness specifications, the shafts must be kept true and free from warpage. Exceptionally close temperature distribution allows conformity to these tough requirements. A unique wiffle tree fixture serves to support the shafts during the nitriding process.

● "Iridite" is a new chemical coating applied to zinc and cadmium surfaces, made by the *Rheem Research Products, Inc.*, Baltimore. It makes possible the use of zinc and cadmium as protective coatings under exposure conditions that have not been possible in the past. Usually 100 gals. of Iridite solution will coat 20,000 sq. ft. of work.

Routine Determinations of Alloying Elements

For determining molybdenum, titanium, vanadium or manganese in steel, lead, copper or iron, the *Central Scientific Co.*, Chicago, is introducing a new type B-2 "Photelometer" of smaller size than usual. It is a compact filter photometer for chemical analyses in the routine or control laboratory.

The Photelometer is easily standardized by determining the transmittancies of a number of solutions that are prepared in accordance with a specific chemical procedure. The transmittancies, when plotted on a semi-logarithmic scale against the known concentrations on a linear scale, yield the analytical curve or standard with which unknown solutions of that technique may be compared.

The barrier-layer instrument consists basically of a low-voltage light source, an adjustable light aperture, a 3-color filter holder, receptacles for tubular or rectangular absorption cells, a single photoelectric cell, and a sensitive current measuring instrument with a 2½-in. scale. The scale reads from 0-100 in 50 divisions.

A voltage transformer to supply constant intensity of light when operated on a controlled frequency power line is furnished with the 115-volt a.c. instrument.

(Continued on page 1210)

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Iron vs. Forged Steel Crankshafts

Engine crankshafts of forged steel are often being replaced with cast Meehanite in the equipment being manufactured by *Cooper-Bessemer Corp.*, Mt. Vernon, Ohio. In one case, in which the crankshaft is block-forged, the steel ingot weighs 36,000 lbs., but the completed shaft only 12,000 lbs., meaning removal of 24,000 lbs. of critical steel by various machining operations. Besides, there is the expenditure of man-hours in sawing, chipping, drilling, turning and boring. During 1936 twelve cast shafts were assembled into engines going into the field, and all have performed satisfactorily since.

Recently *Cooper-Bessemer* conducted their most spectacular test, using a 6-throw shaft casting, 7 ft. 8 in. long, with 5⅜ in. pins and journals to replace the forged steel shaft in an 8¾ in. by 11 in. Diesel engine. First, the engine was operated at 900 lbs. peak pressure for 20,000,000 revolutions at 900 r.p.m. When the bearings were removed and whiting applied, no distress in the shaft was apparent. Then 20,000,000 revolutions more were run at 900 r.p.m. and 1000 lbs. peak pressure. Still in perfect condition! Then it was operated continuously in a peak critical test for 6 days. The sixth night there were indications it had failed.

Another 12 hrs. were added, after which a fracture extending only half way through the shaft was revealed, but it still continued to function. All tests were made of crankshafts of "as cast" process A Meehanite, stress relieved, but not heat treated. In these tests forged shafts of .45 carbon steel with minimum tensile strength of 80,000 per sq. in. were removed from assembled engines and replaced with cast Meehanite shafts.

Contrasts in Tongs

Here is an adventure with steel mill tongs that might well have been encountered in "Gulliver's Travels." The massive tong, pictured herewith, was recently constructed by *Heppenstall Co.*, Pittsburgh, with a lifting capacity of 80 tons, for use with ingots. It has an opening of 69 in. and weighs 12,489 lbs. It eliminates the use of electric power and ground crews.

Look sharply and you can see between the massive claws what appears by comparison to be mere sugar tongs. This smaller one has a lifting capacity of 1600 lbs., and is used for small material.

Electronic Temperature Indicator

A new electronic temperature indicator is announced by *North American Phillips Co., Inc.*, Industrial Electronics Div., 419 Fourth Ave., New York, serving where an expensive recording pyrometer is not required. A switch on the front panel allows selection of three temperature "spread ranges," the standard limits being —212 deg. F. to 1832 deg. F., with a normal accuracy of plus or minus 2 per cent.

Five pairs of terminals for five thermocouples are provided, any one of which can be switched into the circuit so that temperature at five different points can be read. The instrument can be operated with as much as 100 ft. of connecting wire between thermocouples and indicator.

No technical knowledge is required to operate, and the apparatus cannot be damaged by overload or wrong application. The whole apparatus is built into a metal cabinet with black crackle finish, weighs 24 lbs. and it not affected by plant vibrations.

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Magnaflux Service

As originators and pioneers of the Magnaflux Methods, Magnaflux Corporation and its engineering staff have accumulated an unequalled fund of specialized knowledge and experience on this subject. This is placed at the disposal of industry in the service which is extended to Magnaflux users. Included are: training for operators, all necessary text books, regular contacts by field engineers, laboratory services, etc.

MAGNAFLUX CORPORATION

Industry has only just emerged from the phase in which *any inspection* was adopted as a remedy for *no inspection*. The high pressure of war production quickly proved such casually adopted methods inadequate—if not downright threatening to the armament program. It has been the part of the Magnaflux Corporation to advance the overall efficiency by offering continuously improved techniques.

Only deliberate organization to maintain a consistent research program can assure this kind of steady development. The Magnaflux Corporation has chosen to specialize in non-destructive detection of flaws at whatever point promises greatest savings. On the production line this calls for inspection stations, handling every unit, set up between production of parts and the beginning of assembly. In operating equipment, inspections must be made promptly at the time of periodic overhauls.

Within this closely defined field it has proved possible to offer first, magnetic particle inspection (the basic Magnaflux* Method) for all parts susceptible to magnetism—Then, to add black-light inspection of fluorescent magnetic particles (Magnaglo* Method) for magnetic metal parts with darkened or obscured surfaces—Then, to go a step further with black-light fluorescent penetrant inspection of non-magnetic parts (the Zyglo* Method) not only for magnesium alloys, aluminum, bronze, austenitic steels but for ceramics, plastics and solid parts in general.

Magnaflux Research with these sound achievements in practical application, presses on to the fuller development of the Science of Non-Destructive Flaw Detection.

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- **In that capacity it is accompanying our armed forces everywhere.**
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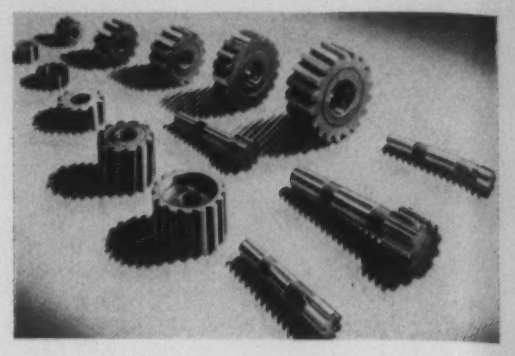
EST. 1875

Standardized Thread Milling Cutters

A line of standardized thread milling cutters has been developed for the first time in industry, it is claimed by *Detroit Tap & Tool Co.*, 8432 Butler St., Detroit 11, the purpose being to speed delivery and simplify



ordering. Blanks are carried in stock, finish-machined and heat-treated, ready for finish grinding of threads. They are produced in the nation's largest plant devoted exclusively to thread milling cutters.

Sizes selected for standardization were chosen after a survey to determine the most widely-used cutter types and sizes. The diameter range of the 40 different shell-type standard blanks are carried, ranging from ¾ to 1½ in. in diam.

● "No-Spat" welding fluid, made by the *Midland Paint & Varnish Co.*, Cleveland, reduces fumes from welding galvanized iron or zinc-coated sheets by at least 30 per cent. A comparison of vaporization showed that an untreated weld on galvanized steel vaporized 0.107 grams of zinc, against 0.074 grams when treated with No-Spat fluid.

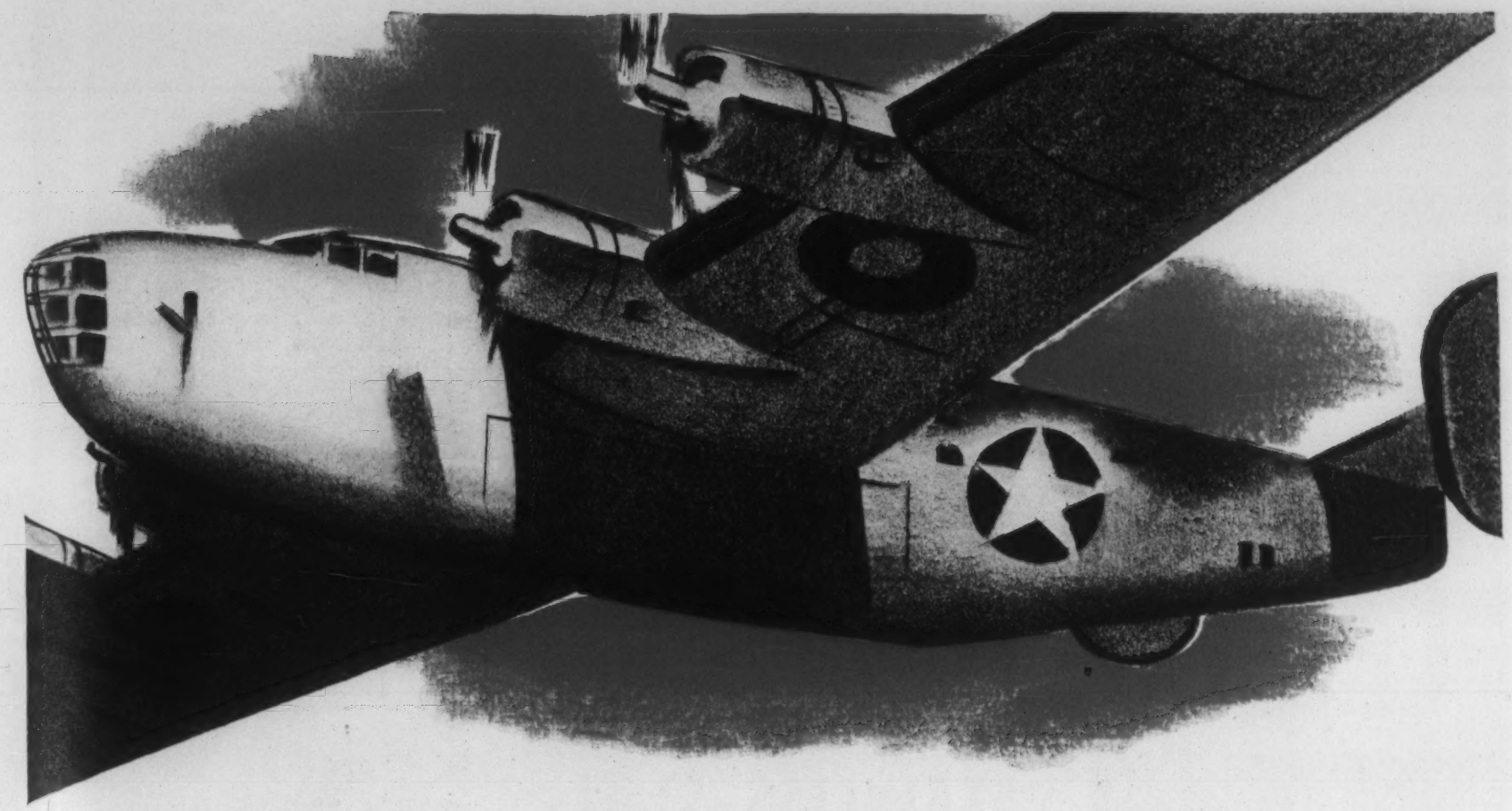
Continuous Draw Furnace

A continuous draw furnace, which was designed for stress-relieving of armor-piercing shot in the plant of an Ohio ordnance manufacturer, is now one of a series of standard units, in various sizes, temperature ranges and capacities, turned out by the *Industrial Oven Engineering Co.*, 11621 Detroit Ave., Cleveland.

Built for ranges up to 900 deg. F., it maintains temperature uniformity plus or minus 3 deg. throughout the work zone. It passes air at extremely high velocities over the work on the conveyor belt and automatically turns the work as it passes through the furnace.

Ventilation hoods with their own exhaust systems protect where workers unload the furnace. Usually loading and unloading are automatic. Fuel cost is 25 per cent original estimates because of efficiently designed air heater, duct and recirculation system. Gas, oil or electric heat may be chosen.

The furnaces are now being used for drawing, tempering and strain-relieving ordnance items and processing cartridge links, clips, etc. They are designed in lower temperature ranges for use as dehydrogenizing ovens, used after pickling, Parkerizing, etc. Electronic safety controls protect from pilot, motor, air or current failure.



THERE FLIES 15 TONS OF HEAT TREATED AL-MG ALLOYS

Why Metallurgists Choose Despatch Furnaces For Such Jobs

A bomber like this is built for trouble—from nose to tail. And most of her 15 tons of tough, light aluminum and magnesium alloys owe their strength to exacting *heat treatment* in specially designed furnaces.

To provide such furnaces has been the role of Despatch engineers for years. So today a very large percentage of *all* non-ferrous alloys used in our military and naval aircraft are "Despatch-processed". Why? Because they are convinced by *proved* performance that Despatch furnaces provide exactly the kind of heat treatment required—swiftly, surely, economically.

PROVIDE BETTER CORROSION-RESISTANCE

Take the bugaboo of corrosion. To get real resistance means most accurate heat treatment and almost split-second quenching. No easy job!

But Despatch engineers developed an electronically controlled dual-zoned type conveyor furnace (shown below) which does the entire job *automatically!* Such high corrosion-resistance was developed that a second furnace was ordered at once for another plant.

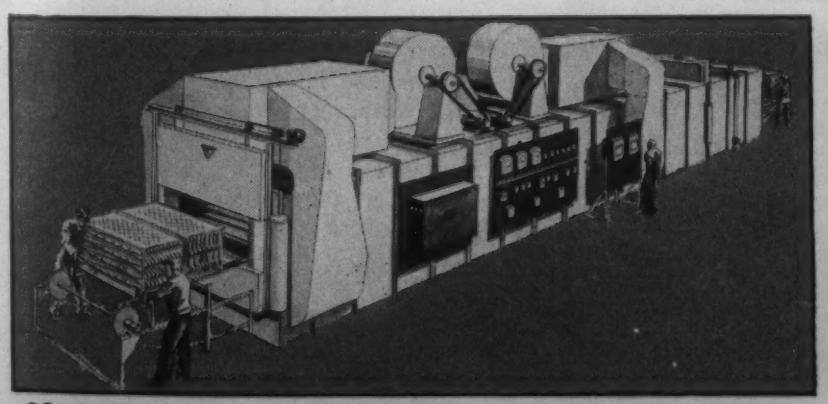
DESPATCH SYSTEM GIVES HIGHEST METAL FACTORS

This is but one example. There are scores of others involving other types of Despatch furnaces for castings, shapes, billets, preforms and rivets.

In all types, however, the unique forced convection system is so powerfully efficient that *maximum* physical factors in tensile and elongation are developed. You get just what you want. And electronic controls, robot conveyors, extra-fast quench systems and other new features help make the job easier and *better*.

WE CAN HELP YOU *with your non-ferrous heat treating problems promptly and efficiently, and also assist you in planning* your *future in the light metals industry.* ASK FOR DETAILS TODAY!

DESPATCH
OVEN COMPANY MINNEAPOLIS



COMPLETELY AUTOMATIC Despatch furnace for heat treating Al. sheets, 400 lbs. per hour. Time-cycle controlled conveyor, doors, quench. Uniformity ± 5° F. Eliminates all labor, except for loading.

ELEVATOR QUENCH system on platform-loaded Despatch furnace allows removal and quench of 8000 lbs. of castings in 20 seconds! Electric or gas-fired (radiant tubes). Very efficient.

Gas Cooler for Annealing, Drawing, Tempering

A new furnace gas cooler, permitting better controlled conditions, resulting in improved annealing, drawing, tempering and stress relieving, is announced by *Brown Fintube Co.*, 1006 Filbert St., Elyria, Ohio. Hot gases are withdrawn from furnace A at temperatures between 1200 and 1600 deg. F. while it is on a heating cycle and passed through this Type BFT-6 cooler, thus reducing their temperature to any desired level, even to 200 deg. or lower.

Cooled gases are then passed into furnace B, where the work may be annealed, drawn, stress relieved, etc. at the exact temperature that produces correct physical qualities — and in a non-oxidizing atmosphere. Thus the work can be cooled, withdrawn and the furnace put back in heat in minimum time.

After furnace B has been recharged and put back on heat, gases from this furnace pass through the cooler and exhausted into A, where work is drawn, annealed, etc. The coolers consist of a bank of resistance-welded, integrally-bonded extended surface fintubes, welded to headers at each end and mounted in an insulated steel shell. Cooling water passes through the inside of the tubes, gases passing between the outside of the tubes and shell.

Because of the fins, tubes are shorter and fewer in number than with plain bare tubes.

DENSICAST

STAINLESS-STEEL CASTINGS WITH INCREASED CORROSION RESISTANCE

DENSICAST—the new Cooper idea for casting 18-8 stainless steel and other high-chrome alloys—provides: Refined grain structure, greater elongation and reduction of area and frequently higher tensile strength, as well as increased corrosion resistance.

If you are interested in stainless steels with characteristics such as these, write for complete information. We shall be glad to discuss your casting problems with you and give you the benefit of our experience in the development of new alloys and new methods of producing corrosion, heat and abrasion resisting castings. You will not be obligated in any way.

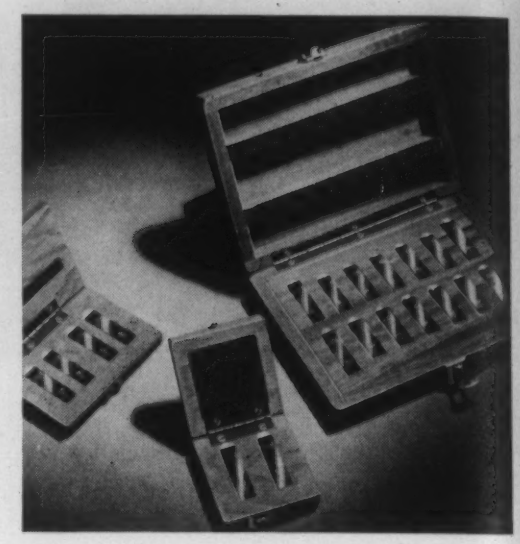
THE *Only* ALLOY FOUNDRY WITH *All* THESE FACILITIES

- Laboratory control over raw materials and finished products.
- Dual foundry . . . both hand and machine molding.
- Centrifugally-cast castings.
- Heat treating of castings up to six feet in size.
- Machine shop . . . specially equipped for finishing stainless steel.
- Improved cleaning . . . including Lustracast electrolytic finishing which leaves all surfaces bright.
- Castings furnished rough, polished or fully machined . . . one ounce to two tons.
- X-ray and Gamma-ray inspection.
- Development of special alloys to meet unusual requirements.
- Technical consulting service.

THE *Cooper* ALLOY FOUNDRY CO.
105 BLOY STREET • HILLSIDE, NEW JERSEY

Cemented Carbide Gage Blocks

Gage blocks made of cemented carbide, which greatly reduce wear error, are announced by the *Lincoln Park Tool & Gage Co.*, Lincoln Park 25, Mich. Named "Carblox," they will retain their accurate size within the allowable wear tolerance at least 50 times longer than steel blocks, the maker claims. They are non-magnetic and resistant to corrosion. Their high cohesive factor facilitates the wringing of thin blocks.



Carblox are furnished to "A" accuracy (0.000004 in.) and "B" accuracy (0.000008 in.), as a series of a gage block build-up is not required.

● In addition to shipping carbide powder to England since Sept. 1, 1939, the U. S. carbide industry has been supplying Canada, Russia, Australia, China, Mexico, South Africa, India and other United Nations with carbides in various forms — from raw material to finished product, states *Carboloy Co., Inc.*, Detroit.

Mass Production X-Ray Machine

A new mass production X-ray machine capable of inspecting 17,000 airplane castings in 24 hrs. has been developed for a Detroit plant, *Westinghouse* engineers state. Key to the speed is a moving conveyor, 40 ft. long and 3 ft. wide, that transports castings through the inspection, which is done inside two steel towers, 12 ft. high and near the middle of the conveyor.

Each tower houses an X-ray tube, one operating at 140,000 volts, the other at 220,000, so that castings of different types and thicknesses can be examined at the same time. For quickly identifying any defective castings, corresponding numbers are given the film and the castings. Because of lead-lined hoods to protect workmen, the inspection unit can be located anywhere in the plant. The machine will be used chiefly to test aluminum castings.

Official Signal Corps Photo

Sergeant Altimoso has himself a job

He's trying to remove rust from the huge pile of salvaged weapons collected from the jungle battlefields of New Guinea.

The sergeant may be able to put many of those rifles in usable condition, but the tropics aren't easy on metals. That's why Uncle Sam realizes he has another enemy to fight. Its name is RUST.

This fight starts back in the steel mill, down through the machining, the assembly, storage, shipping and the long delays awaiting invasion.

Specifications carefully worked out by the Army, Navy and Air Corps now cover almost all needs. But a rust preventive should do more than merely meet a "spec." It should be so made that it *exceeds* the protective minimum. Houghton rust preventives provide that "plus" service.

Whether it be a slush, or a light waxy film, or one which dries hard, or a heavy grease, you'll find a Houghton product ready to serve you well.

For Lend-Lease steel shipments, too, for which the A.I.S.I. has worked out rust preventive recommendations, the Houghton Man is ready to prescribe the correct Cosmoline or Rust Veto.

To the plant man concerned with rusting between operations, we can offer suggestions on the cleaning of steel surfaces prior to their protective coating. Write to E. F. Houghton & Co., Philadelphia, Chicago, Detroit, San Francisco or Toronto.

Houghton's RUST Preventives

Open Mesh Annealing Trays

Open mesh steel grating has replaced special plate steel trays in the heat treatment of metal bottles used to inflate life rafts for airmen and extinguish fires in aircraft, tanks, etc. with carbon dioxide gas. The idea of using 84 per cent open steel grid in place of the solid type tray for annealing was inspired by *Walter Kidde Co.*, Belleville, N. J. Their engineers became increasingly dissatisfied with the lack of tempering uniformity with the trays.

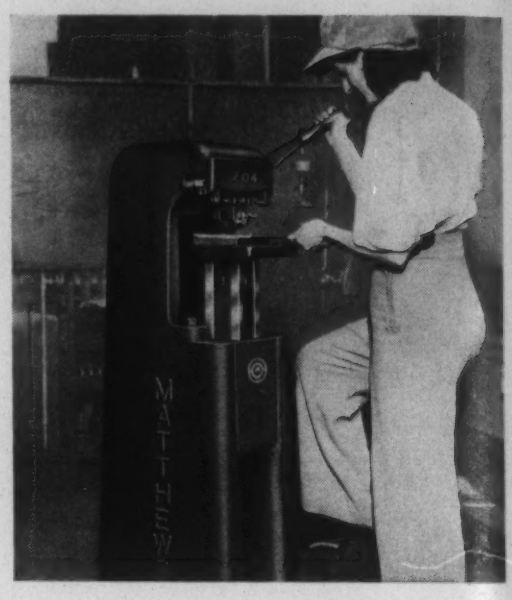
They approached the *Irving Subway Grating Co.*, 152 W. 42nd St., New York, with the idea of making open mesh trays, and by now 200 are in use. The steel bottles are made from discs ranging in diameter from 6 to 24 in. Each slug is first put in a press and formed into a cup-like shape. It is annealed and again drawn, the complete process calling for seven draws and annealings.

The material slides through the annealing ovens at 1300 deg. F. on the grating trays over a period of 1 hr. 5 mins. The 84 per cent open area in the mesh trays allows for the same temperature throughout.

The trays are made up of ¾ by ⅛ in. straight bars spaced 1¾ in. on centers, and ¾ by ⅛ in. reticuline bars assembled with ¼ in. gun driven rivets 7 in. on centers. Size of the trays are 38 by 44 in. Irving engineers believe that a new field has been opened up.

General Purpose Marking Machine

A new general-purpose marking machine will mark most any flat or round product. It can be furnished with a motorized unit



or with a pneumatic attachment. Known as No. 204, it is made by *Jas. H. Matthews & Co.*, 3942 Forbes St., Pittsburgh.

The machine is used for clear-cut, legible marking of part numbers, patent numbers, names, coding, trade-marks, special lettering or design on a range of shapes and sizes of parts up to 6 in. diam. or thickness. The maker describes nine outstanding features.

● Trichlorethylene, a chlorinated hydrocarbon, cleans metals of the minutest particles of grease, states *E. I. duPont de Nemours & Co., Inc.*, Wilmington, Del. Solvent degreasing works four times as fast as other cleaning processes, and can be done in a quarter of the factory space required for other processes. It is nonflammable and should have several peacetime uses.

Quick Return Drive Press

A mechanical reducing press with quick return drive has increased speed facilities on redraw operations. Known as No. 88-A, it is made by *E. W. Bliss Co.*, 53rd St. & Second Ave., Brooklyn 32, New York. It permits operation at a materially increased rate, in strokes per minute, without any increase in the drawing speed. The quick return principle resembles the action of shapers and planers in metal cutting.

Twin driving gears divide the torsional load between two slides and slabs of the shaft. The machine is of 4-piece steel tie-rod frame construction with double gearing, operating at 14 strokes per min. It is equipped with a multiple disc, flywheel type, air friction clutch and brake with push button control. A 6-station dial feed is employed.

1. Increases the productive life of steel parts 3 to 15 times.
2. Quickly and economically restores worn surfaces subject to severe abrasion.
3. Can be applied quickly with oxy-acetylene torch.
4. Can be applied in thin layers—having a melting point lower than the steel base.
5. Does not oxidize and is not readily affected by mild acids.
6. Can be applied on surfaces previously hard-faced.
7. Is extremely resistant to abrasive wear at elevated temperatures.
8. Will increase the productivity of machine tools.
9. Eliminates costly delays by prolonging life of parts.

CALLITE "NO-WEAR" METAL

Density: 170 grams per cu. in. 1 lb. covers approximately 90 sq. in., 1/32" thick. Hardness: (Rockwell Scale) 63-67 cast; 62-66 gas-welded.

Send for No-Wear Bulletin No. 153

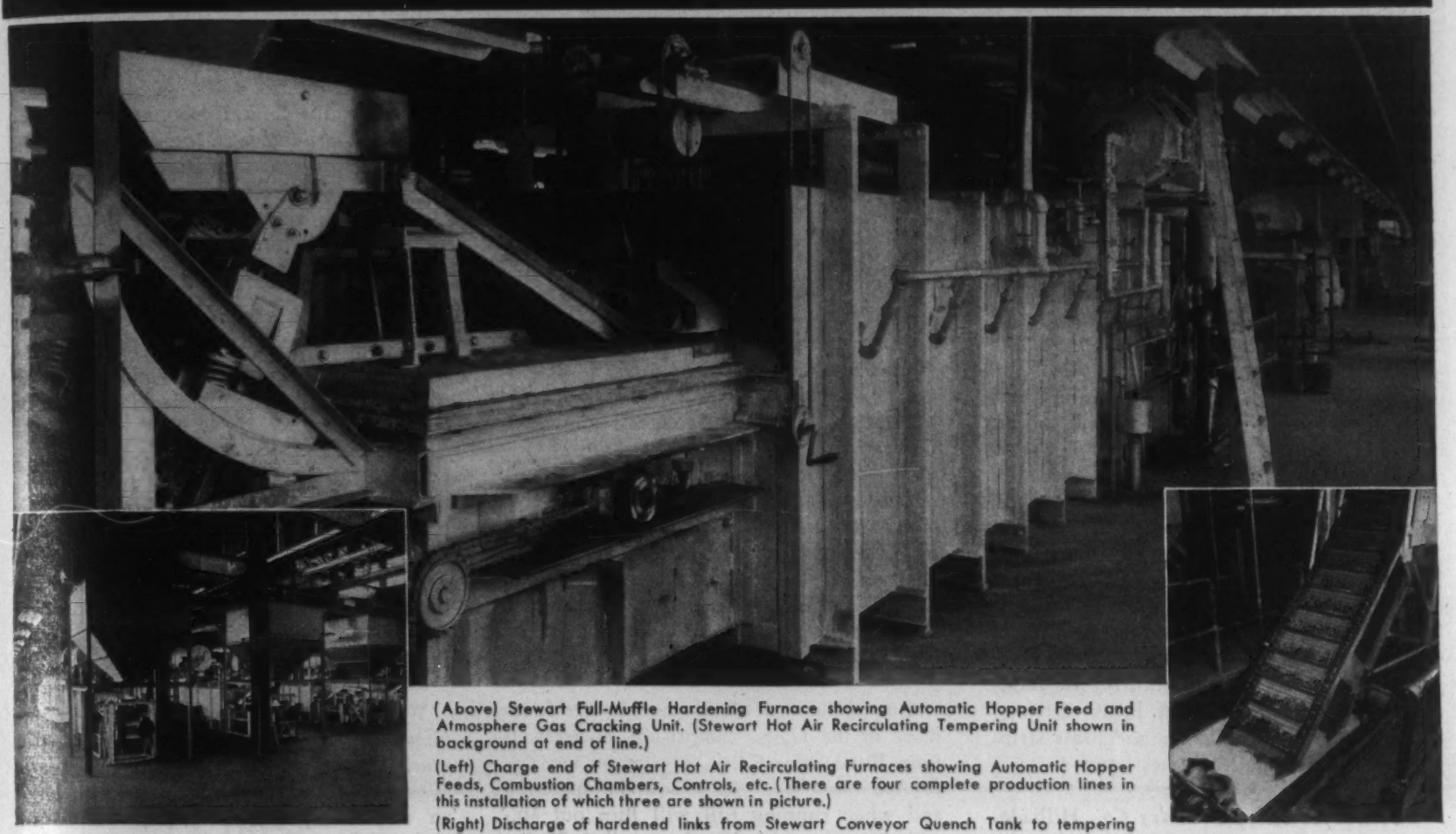
CALLITE TUNGSTEN CORPORATION
572 — 39th STREET, UNION CITY, N. J.
Branches: Cleveland, Chicago

HEAT TREATING MACHINE GUN LINKS *with*

STEWART

THE BEST INDUSTRIAL FURNACES MADE

No. 48 OF A SERIES of Typical Installations



(Above) Stewart Full-Muffle Hardening Furnace showing Automatic Hopper Feed and Atmosphere Gas Cracking Unit. (Stewart Hot Air Recirculating Tempering Unit shown in background at end of line.)

(Left) Charge end of Stewart Hot Air Recirculating Furnaces showing Automatic Hopper Feeds, Combustion Chambers, Controls, etc. (There are four complete production lines in this installation of which three are shown in picture.)

(Right) Discharge of hardened links from Stewart Conveyor Quench Tank to tempering in Stewart Hot Air Recirculating Draw Furnace.

Four production lines of Stewart machine gun link heat treating equipment are meeting rigid operating and metallurgical specifications for a large eastern manufacturer. Each line consists of a hardening furnace, quench tank and draw furnace, and has a capacity of 1100 lbs. per hour and is exceeding its rated capacity.

The hardening furnace is of the continuous full-muffle type with controlled atmosphere. Uniform, thorough quenching is assured by the special design of quench chute in the Stewart conveyor type quench tanks to provide a vigorous agitation and recirculation of a large volume of controlled temperature quenching oil in the critical cooling area.

The tempering furnace is the hot air recirculating type with complete automatic temperature control and variable speed control of heating time and cycle.

This installation is typical of the industrial furnaces Stewart engineers are building every day to meet the specified requirements of manufacturers all over the continent. In addition to furnaces especially designed to meet specific needs, Stewart also builds a full line of standard-type furnaces.

STEWART VEST-POCKET HEAT TREATING DATA BOOK

Write for Your Free Copy

Sixty-eight pages of charts, tables, diagrams and factual data on latest steel specifications, characteristics and applications, heat treatments, heating time allowances, hardness and tempering conversion tables, carburizing, case hardening, cyaniding, quenching notes, furnace capacity information, melting points of common metals, etc. Handy, vest-pocket size. We will gladly send you a copy upon request.

A letter, wire or 'phone call will promptly bring you information and details on STEWART Furnaces, either units for which plans are now ready or units especially designed to meet your needs. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat-treating problems with you.

STEWART INDUSTRIAL FURNACE DIV. of CHICAGO FLEXIBLE SHAFT CO.

Main Office: **5600 W. Roosevelt Road, Chicago 50, Illinois**

Canada Factory: (FLEXIBLE SHAFT CO., LTD.) 321 Weston Rd., So., Toronto

News of Men, Societies, Meetings and Companies

Plants and Slants

Operations in the Mediterranean on the part of the Allies have resulted in many items of commerce, several of which are vital to munitions manufacture, being removed from the Axis sphere of influence and turned over to the Allies. Germany has already been cut off from vital supplies of sulphur, phosphates and other critical materials. Now that we dominate Mussolini's former sea, we can readily get Turkish chrome ore and other products.

One of the items made more readily accessible to us is pumice from the island of Lipari, off the Italian Coast. Pumice from this volcanic isle has long been considered by American industry as the finest in the world. The recent capture of Lipari has meant that for the second time in 30 years the mines of *James H. Rhodes & Co.*, 157 W. Hubbard St., Chicago 10, have been retaken from enemy hands.

The Nazis are also going to miss the Italian output of mercury, bauxite, borax, zinc and lead.

After 63 years of consecutive service, Charles Buckingham has retired from the *Seymour Mfg. Co.*, Seymour, Conn., having become an employee three years after the company was organized. For 60 years he has been a shipping clerk. During the first world war he saw his company convert from peace time silver and phosphor bronze products to the manufacture of brass cartridge discs, copper rotating bands and brass strip. He saw this repeated 25 years later.

The *Cooper Alloy Foundry Co.*, Hillside, N. J. has completed a new plant for the manufacture of centrifugally-cast alloy castings for aircraft and other services which substitute for forgings and fabricated parts. The company specializes in corrosion and heat-resisting alloys.

The plant of the *Claude B. Schneible Co.*, maker of dust, fume and odor control equipment, at 2827 Twenty-fifth St., Detroit, has become headquarters for the organization, engineering, sales and production becoming consolidated at that place.

Back in 1931 the *Cooper-Bessemer Corp.* experimented successfully with employing women as coremakers at their Grove City, Pa. plant. This 12-year old experiment is paying big dividends, for today women are playing an increasingly important part in foundry core production.

The four New Jersey foundries of *Bendix Aviation Corp.*, which were among the nation's pioneers in perfecting casting of magnesium for the aircraft industry, are averaging 400,000 lbs. of magnesium castings monthly but soon increased facilities will boost this total to exceed 8,500,000 lbs. annually. In 1931 magnesium castings represented only 17 per cent of the corporation's foundry output; today it is 50 per cent.

In a feature article on "Magnesium Fires" in this magazine last spring, the address of the *St. Regis Paper Co.* erroneously appeared as Otsego, N. Y. The correct address is Oswego, N. Y.

United States Steel Products Co. has bought the manufacturing assets of the *Petroleum Iron Works Co.*, with plants at Sharon, Pa. and Port Arthur and Beaumont, Texas. Temporary executive offices have been established at 30 Rockefeller Plaza, New York.

One of the largest and most modern foundries in the U. S., comprising 43 acres, is near Pittsburgh, Calif., a part of the *Columbia Steel Co.* It is now in operation and when running full will turn out 30,000 tons of steel castings annually. It cost $6,000,000, has two 25-ton basic open hearth furnaces, with a 6-ton electric furnace due soon.

Heller Brothers Co., Newark, N. J., maker of files, rasps, tools and steel, has acquired the goodwill, trade name and patents of the *Cleveland File Co.*, Cleveland.

Detrex Corp. replaces *Detroit Rex Products Co.*, metal cleaning engineers, as the new firm name.

Van Norman Co. has succeeded *Van Norman Machine Tool Co.* as the firm name, the address being the same at Springfield 7, Mass.

The *Carbide Tool Co.*, Chicago, has renamed its principal division the *Lake Shore Tool Works.*

Executive offices, sales, engineering, purchasing and technical laboratories of *Advance Pressure Castings, Inc.* are now located at 894 Manhattan Ave., Brooklyn 22, N. Y.

The name of the *Porcelain Enamel & Mfg. Co.* of Baltimore has been changed to *Pemco Corp.*

North American Philips Co., Inc., Dobbs Ferry, N. Y., will move its commercial and administrative departments late in November to the Pershing Square Bldg., Park Ave. at 42nd St., New York.

The *Alvey-Ferguson Co.* of California has been formed, with sales offices, engineering and manufacturing facilities at Slauson and Santa Fe Avenues, Los Angeles, their products being the same as those of the original company at Cincinnati, *i.e.* conveying, metal products cleaning and finishing equipment.

When the *Geneva Steel Co.* is completed at Provo, Utah, at the end of the year, it will be the largest steel plant West of the Mississippi. It will have an annual capacity of 1,200,000 tons of ingots, 700,000 tons of plates and 250,000 tons of structural steel. It is a U. S. Steel subsidiary.

Assorted baseball equipment, footballs, boxing gloves, fishing tackle, games and magazine subscriptions were recently donated to the crew of a U. S. minesweeper by the management and employees of the *Ohio Crankshaft Co.*, Cleveland. The company machined the crankshafts and camshafts of this vessel, hence the fatherly interest.

CHECK THESE CUTTING TIMES

HIGH SPEED STEEL
1" Round, 2 1/5 seconds

ROLLER BEARING STOCK
1 5/16" O.D., 2 1/2 seconds

UNANNEALED STAINLESS STEEL
1" Square, 2 1/2 seconds

CHROME MOLYBDENUM
1 1/2" O.D., 1 1/2 seconds

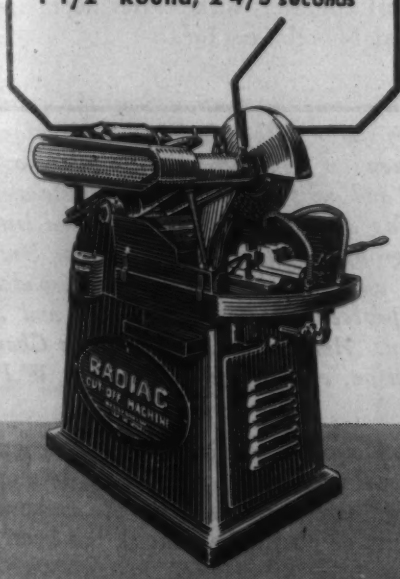
TOBIN BRONZE
1 1/2" Round, 2 4/5 seconds

We've illustrated a cucumber to give you a good idea how a Radiac Cut-off Machine works. The fact is, it cuts through bars, rods, and tubes of metal or other materials as easily as you could slice a cucumber. As an example, look at the time for cutting off 1 5/16" roller bearing stock—a mere 2½ seconds!

What's more, the Radiac Cut-off Machine (equipped with a Radiac Abrasive Cut-off Disc) whistles through these materials in one clean, true stroke. Hardly ever is any finishing required because of the smooth, ground finish.

Radiac cutting is "cool as a cucumber," too, no burning or bluing since cuts are made well below carbonization temperatures.

If you have any quantity of cutting-off to do, write promptly for information about the seven types of Radiac Cut-off Machines. Just drop a post card to A. P. de Sanno & Son, Inc., Machine Sales Division, 106 South 16th Street, Philadelphia, Penna. Plant: Phoenixville, Penna.



TYPE K—Wet and Dry Cutting

RADIAC*

ABRASIVE CUT-OFF MACHINES

*T. M. Reg. U. S. Pat. Off.

Copyright 1943, A. P. de Sanno & Son, Inc.

Representatives in:

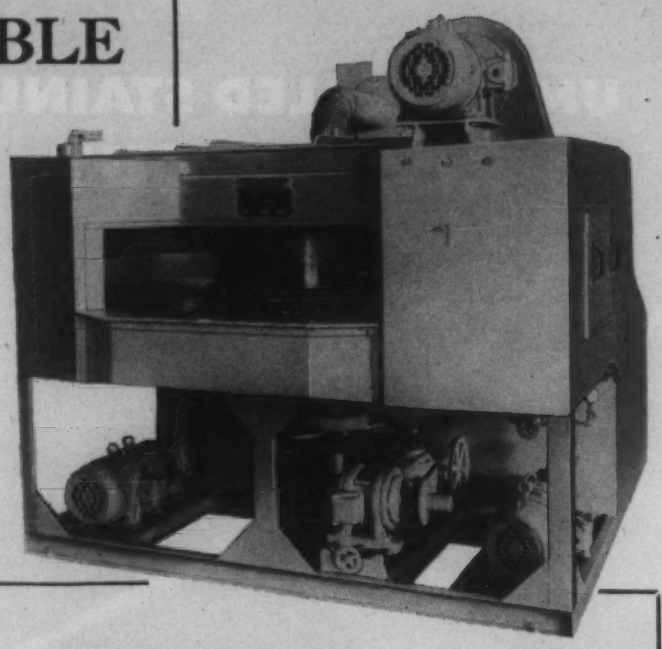
BUFFALO	COLUMBUS	DETROIT	NEW YORK	SAN FRANCISCO
CHICAGO	DALLAS	KANSAS CITY	PHILADELPHIA	ST. LOUIS
CLEVELAND	DENVER	LOS ANGELES	PITTSBURGH	SEATTLE

ROTO-TABLE

Automatic Wash, Rinse and Drying Machine

Operated by one man

— Another Important Product for the War effort



Special Features of Above Machine

- Rugged Construction
- Minimum Floor Space
- Work is placed on Roto Table and returns to operator
- Large Production Capacity
- Conveying Table width 21 in.—working height 12 in.
- Immediate accessibility to all working parts.

A newly designed machine for rapid cleaning of metal parts, pump castings and similar objects by means of spirit solvents.

Can be readily converted for use of alkali cleaners.

There are large and small Metalwash Roto-Table type machines in operation from single stage Washing Machines to the multiple stage cleaning and drying types; or for other surface treatments of metal parts.

We also manufacture complete lines of Flat Belt Conveyor Machines, Roller Conveyor or Revolving **Pickling Machines, and other special equipment used** in the cleaning and finishing of metal parts.

We invite your inquiries. Request our Special Bulletin M A.

METALWASH MACHINERY CO.

149-155 Shaw Avenue Irvington, N. J.

Meetings and Expositions

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS, annual meeting. Pittsburgh, Pa. November 15-16, 1943.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, annual meeting. New York, N. Y. November 29-December 3, 1943.

NATIONAL CHEMICAL EXPOSITION. New York, N. Y. December 6-11, 1943.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 10-14, 1944.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. January 25-27, 1944.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, 50th anniversary meeting. New York, N. Y. January 31-February 2nd, 1944.

Briefs on Associations, Promotions, and Education

"Although there are records of the experimental use of boron as an alloying agent in steels as early as 1917, the additive treatment of steel from a commercial standpoint is relatively new, having started in 1938," stated R. B. Schenck, chief metallurgist, Buick Motor Div., before the National Tractor session of the Society of Automotive Engineers at Milwaukee in late September.

The Engineering Societies Committee on War Production has arranged another group of panel sessions following a dinner meeting on Nov. 9 at the Pennsylvania Hotel, New York. Here manufacturers, large and small, exchange experiences on live problems on- engineering, management, shop practices and manpower. WPB requested the meeting.

Among current problems discussed at the meeting of the Gray Iron Founders' Society at Cincinnati, Oct. 5 and 6, were the lack of price flexibility involving ceiling wages and ceiling prices for castings, the extreme manpower shortage (which is perhaps the most severe of any branch of metals industry) and the place of gray iron castings in the post-war. Walter L. Seelbach, Forest City Foundries, Cleveland, was elected president and W. W. Rose continues as executive secretary.

Harry W. Dietert Co., 9330 Roselawn Ave., Detroit 4, has started publication of a small bi-monthly paper of interest to spectographers and spectographic laboratory personnel. Its purpose is to disseminate technical information and to outline latest developments. Interested parties will be placed on the mailing list.

The American Institute of Physics has bought the 5-story former residence at 57-59 E. 55th St., New York, for a national headquarters of the organization and its affiliated scientific societies. The Institute was founded in 1931.

A newly-designed "safety schooner," which visits workers at their benches and repairs anti-accident equipment without interruption of production functions at Willys-Overland Motors, Inc., Toledo, Ohio. Over 14,000 employees are thus serviced on such items as goggles, aprons, safety shoes, helmets and face shields.

Commerce and industry will be responsible for raising $12,000,000 of the $17,000,000 which New York City is asked to provide in the campaign of the National War Fund. This was told to editors and publishers of over 300 business and trade papers at the Hotel Roosevelt, New York, on Sept. 13. The funds will be used for the U.S.O., United Seamen's Service and 15 other major organizations of kindred purpose.

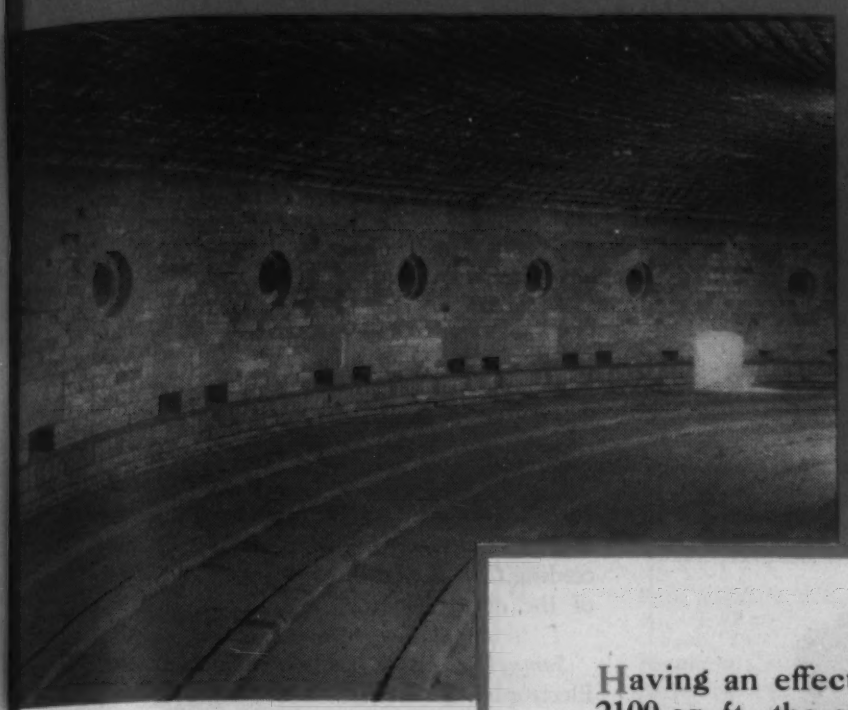
Steel will retain its place as the dominant metal after the war, stated Wilfred Sykes, president, Inland Steel Co. before the Iron & Steel Engineers at Pittsburgh in late September. "There is no other metal that has the unique properties which make steel so valuable from engineering and constructional standpoints." He estimated 75,000,000 tons of capacity annually in U. S. steel plants "that can be economically operative and be competitive in post-war years."

The American Society for Testing Materials has elected Robert J. McKay as chairman of its committee, B-8, on electrodeposited metallic coatings. Mr. McKay is chemical engineer, nickel sales dept., International Nickel Co., Inc.

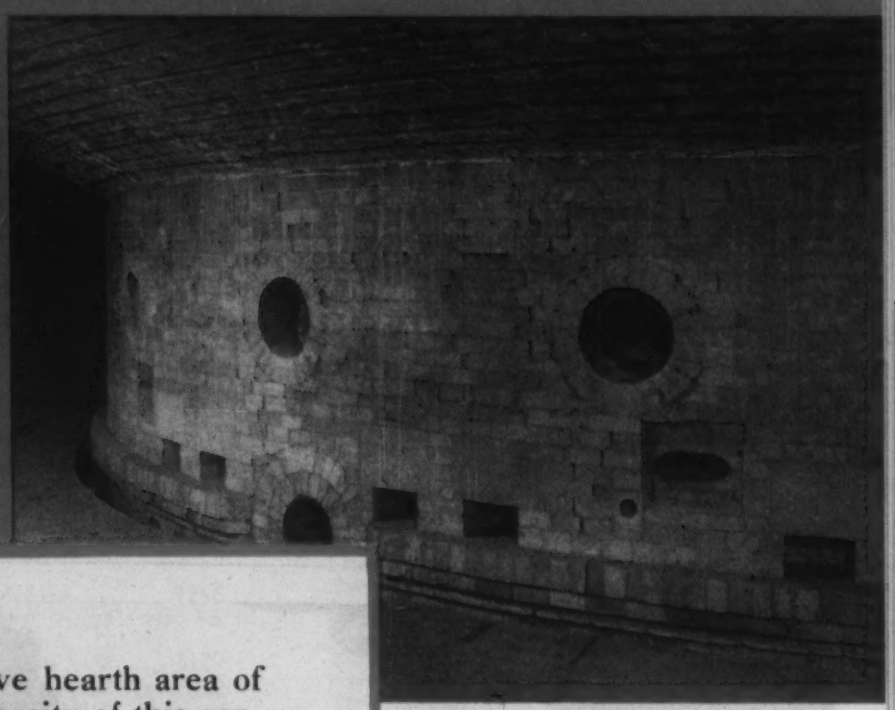
A war-time innovation was the convention by radio of the National Association of Foremen on Sept. 26 to save time, avoid travel and omit that dark brown taste of the morning after. Foremen's clubs and listening groups met throughout the United States and Canada, received the broadcast, then proceeded to local business and discussion. Among the speakers were Charles E. Wilson, executive vice chairman, W.P.B.

The National Security Award to recognize those industrial plants which have developed superior safeguards against fire, sabotage, accidents or possible air attack has been inaugurated by the United States Office of Civilian Defense. Emblems will be given plants and the sponsors hope it will have

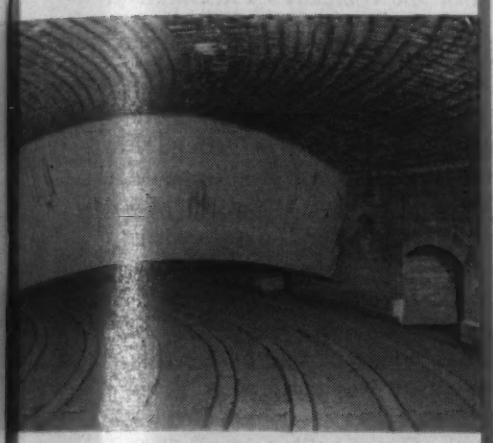
THE WORLD'S LARGEST ROTARY FURNACE BUILT BY SALEM



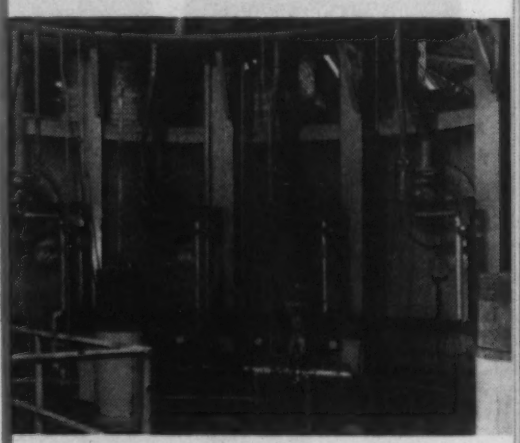
1 *The inside surface of the outside wall, showing firing and exhaust ports as well as piers of the rotating hearth on which billets rest.*



4 *Additional ports on the convex surface of the inside wall. Wall to wall width is 16½ ft. Effective loading width of hearth is 14 ft.*

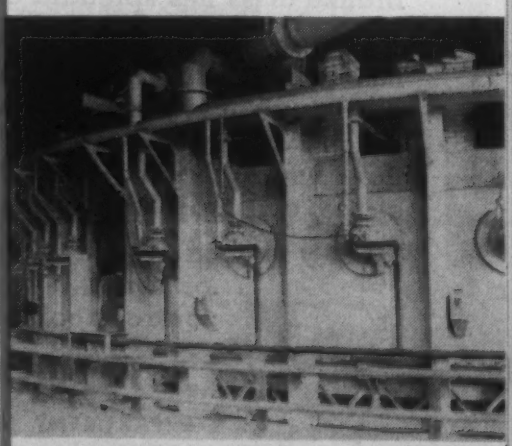


2 *The refractory type baffle between charging and discharging doors protects hot billets being discharged from harmful effects of cold billets being charged.*



5 *On the inside of the "doughnut" are located burners which fire through the ports that are shown in Picture No. 4.*

3 *A special designed water-cooled peel charges and discharges billets. The hearth moves continuously or may be operated intermittently, if desired.*



6 *Burners around the perimeter of the outside wall. Each set of burners is equipped with precise temperature controls.*

Having an effective hearth area of 2100 sq. ft., the capacity of this continuous tunnel type Salem Rotary Billet Heating Furnace is 80,000 lbs. per hour at 2250° F. when heating 10" billets on a 5 hour cycle. It is gas fired, and it is equipped for oil as a stand-by fuel. Billets ranging from 4" to 10" in diameter and from 5' to 14' in length are heated prior to piercing with a maximum scale loss of ½ of 1%. The temperature for each of the five zones in the furnace is automatically recorded and a dial chart, which revolves with the furnace, enables the operator to locate any billet during the heating period.

The hearth is equipped with variable speed mechanism which gives a range of 2 to 8 hours per revolution. A refractory type baffle between charging and discharging doors prevents cold billets, which are being charged, from having a detrimental effect on billets being discharged. For heating certain alloy steels, which require lower charging temperatures and longer heating-up cycles, a removable section of cooling pipes may be placed between the baffle and charging door. Salem will design a similar furnace, or any other type, for your specific needs.

SALEM ENGINEERING COMPANY

SALEM ENGINEERING CO. · SALEM, OHIO

the same dignity as the Army-Navy "E" award.

The Allegheny Ludlum Steel Corp. has put out a motion picture, "Welding Stainless Steel," 2-reels, 25 minutes. Particularly unique are the extreme close-ups of the arc at work, greatly magnified.

Two moving picture films, the Dial Indicator and the Dial Indicator Gages, have been put out by Federal Products Corp., 1144 Eddy St., Providence.

A Navy Department mobile exhibit of ordnance equipment, accompanied by returned combat veterans, is touring important steel producing centers in support of WPB's "Steel for Victory" drive.

Cornelius Francis Kelley, chairman, Anaconda Copper Mining Co., has been awarded the Charles F. Rand Memorial medal for "distinguished achievement in mining administration" by the American Institute of Mining and Metallurgical Engineers. Mr. Kelley is the second recipient of the Rand medal, the first having been *Robert Crooks Stanley,* chairman, International Nickel Co.

Thomas A. Wright has been elected president, *John Jicha,* vice president and chemical director, and *Dr. Robert H. Bell,* vice president and research director of Lucius Pitkin, Inc., 47 Fulton St., New York.

News of Engineers

Carl G. Strandlung, formerly in charge of their armor plate division, has been made vice president and general manager, Chicago Vitreous Enamel Product Co., Cicero, Ill. Before joining this company 18 years ago, he was a consulting engineer.

Tinkham Veale, II has been made production manager of the Tocco Induction Process Div., Ohio Crankshaft Co., Cleveland. His previous company connection was Reliance Electric & Engineering Co.

Charles F. Dickinson has become assistant manager, metallurgical division, Chicago district, Carnegie-Illinois Steel Corp., succeeding *L. J. Rohl,* who has become manager of the department.

Samuel G. Baker has been made director, Electroplating Div., E. I. duPont de Nemours & Co., Wilmington, Del., having previously been director of sales of the explosives department. He is a chemical engineer by schooling and experience.

Thomas I. Phillips, vice president, Westinghouse Electric & Mfg. Co., has been made head of the company's Pittsburgh divisions. He started with Westinghouse 28 years ago as a tool maker.

Van S. Wielosinski has been appointed plant metallurgist at Willys-Overland Motors. He came from Carnegie-Illinois Steel Corp., Chicago, where for 7 years he did metallurgical research and development.

Clarence C. Helmle has joined the technical staff of the Enthone Co., New Haven, Conn., where he will be engaged in plating equipment design, process development and technical service. Previously he was with General Electric at Bridgeport in charge of electroplating, metallurgy and general chemistry.

Richard Hammerstein and *T. J. Clark* have joined the engineering staff of the Park Chemical Co., Detroit. The former has been in industrial metallurgy with Carnegie-Illinois, Crucible Steel and Oldsmobile. Mr. Clark has specialized in heat treating, both with R.C.A. Mfg. Co. and Brown Instrument Co.

Frank J. De Rewal, formerly with Battelle Memorial Institute, is now in charge of Metallurgical research and development for Delloy Metals, Philadelphia.

C. Malcolm Allen has joined Battelle Memorial Institute, where he will do research work on the engineering properties of metals. Previously he was with the Liquid Cooled Engine Div., Aviation Corp., Toledo, Ohio.

F. L. Magee, product manager for sheet, Aluminum Co. of America, has been promoted to general production manager and *I. W. Wilson,* of the same company, to assistant to vice president. *Donovan Wilmot* becomes product manager for sheet. *Ralph W. Davies* goes to Pittsburgh to be product manager for ingot.

A portable combination pump unit, consisting of a fuel pump and bilge pump. Pumps fuel into aircraft tank and removes bilge water from seaplane body. Bilge pump in foreground.
Corrosion Resistant!

Bilge-pump bodies of AMPCO METAL resist salt water — *have longer life*

The corrosive action of salt-laden bilge water calls for the use of a corrosion-resistant metal in bilge pumps used by many U. S. Navy seaplanes. Longer life and maximum service are assured through the use of Ampco Metal, as this alloy of the aluminum bronze class has splendid corrosion-resistant properties.

You may need an acid- and corrosion-resistant material which has — coupled with these properties — high tensile strength and excellent wear-resistance. The remarkable physical properties of "Ampco" bronzes lend themselves to many applications where unusual service is required which will affect length of life, economy, and, in many cases, operating safety.

When you need bronze parts to stand up against corrosion, wear, or metal fatigue, investigate Ampco Metal. Send for free booklet, "File 41—Engineering Data Sheets."

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Industrial Steels, Inc. 1100
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Agency—Renner Advertisers
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Agency—Marschalk and Pratt Co.

Johns-Manville Corp. 1148, 1238
Agency—J. Walter Thompson Co.
★ Johnson Bronze Co. 1176
Agency—Wearstler Advertising, Inc.
Johnson, S. C., & Son, Inc. 1224
Agency—Needham, Louis & Brorby, Inc.

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Agency—Keelor & Stites Co.
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King, Andrew 1246
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Agency—M. Glen Miller
Linde Air Products Co. 1037, 1038, 1039, 1040
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Agency—Grady & Wagner
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McKay Co. 1161
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Agency—Gardner Advertising Co.
Monsanto Chemical Co., Merrimac Div. 1245
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Agency—Richard Thorndike

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Timken Roller Bearing Co., Steel & Tube Division 1225
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trends

By Edwin F. Cone

Battlefield Scrap

A recent estimate of the amount of scrap, which will be brought back to the United States, is 20,000 to 25,000 tons per month. If plans are made to process some of this scrap in Italy, this volume may decrease.

Cupola Charging

The application of mechanical charging to cupola operations is increasing. One large foundry which melts 50 tons an hour until recently used 18 men to charge the cupolas—today these same cupolas are being charged mechanically with 3 men.

Lend-Lease Exports

Exports under Lend-Lease constitute about four-fifths of our total exports. Much of this is munitions and metals in various forms. Exports of U. S. merchandise in June were valued at $998,000,000 and lend-lease were worth $792,000,000.

Iron Ore Supplies

There is no immediate danger of a shortage of high-grade iron ore in the United States, even if a wartime consumption of 100,000,000 gross tons a year continues, according to a statement of the National Industrial Conference Board.

Electric Steel in Ohio

The State of Ohio continues to lead in the production of electric steel as it has for several years. Out of a total for 1942 of 3,974,540 net tons, Ohio is credited with 1,564,137 tons. Pennsylvania is second with Indiana, Illinois and Michigan third.

Open-Hearth Steel Furnace Operation

Speaking before a local section of a large technical society, C. D. King, chairman, operating committee U. S. Steel Corp., comparing open-hearth operations of one of the company's plants in the Pittsburgh district now and in the first World War, said: "In 1918 this plant was considered a modern unit by the old standards and at that time was tapping 110 net ton heats with a daily production of 194 tons per furnace and a fuel consumption of 6,600,000 Btu's per net ton of ingots. The plant has since been improved and by any present standards is considered a representative modern unit. Today (Sept. 30) the furnaces are tapping 169 net ton heats, or 53 per cent larger, producing 310 net tons per day per furnace or 60 per cent more, and consuming 3,700,000 Btu's per net ton of ingots or 44 per cent less." Though the furnaces are larger, there have been many improvements in design, in methods of operation and in furnace control.

Post-War Magnesium and Aluminum

After the war, the Government will own about 92 per cent of the country's magnesium capacity and more than 50 per cent of the aluminum, as well as 10 per cent of the steel, said Jesse Jones, chairman of the R. F. C., in a recent statement. This ownership will constitute a vital problem in the post-war economy. The Government will be in a position after the war to smother private industry in the manufacture of magnesium and to dominate the aluminum industry. These situations, he declared, will require wisdom and fairness by the Government if private investments are not destroyed. "We have built and own 45 plants for the fabrication of aluminum."

Magnesium Castings

The output of magnesium castings has reached a rate 3 times as great as at the time of Pearl Harbor, according to WPB. This does not include incendiary bomb magnesium castings which also have shown large production increases.

The largest increase has been in sand castings — from 1,500,000 lbs. in November 1941 to over 4,500,000 lbs. per month in the spring of this year. Both permanent mold and die castings show large percentage gains in the same period. Permanent mold castings reached a peak of 356,000 lbs. and die castings 274,000 lbs. in May 1943 — increases of more than 1400 and 400 per cent respectively over prewar output.

Brazilian Aluminum

Brazil's importations of American aluminum has been about 1,600 tons annually until American war demands cut off this supply. There will soon be a new Brazilian aluminum industry, the generators and transformers for new power stations being now installed. Raw material for this new industry consists of 81 known deposits of bauxite in Brazil, estimated to contain 150,000,000 tons.

Electric Steel Capacity

The capacity of American electric steel furnaces continues to increase. In August the total, rated at 4,936,000 net tons per year, was 400,000 tons above the capacity as of Jan. 1, this year and more than 2½ times the capacity available in 1940. This is very rapid expansion.